TENTH ILLINOIS CUSTOM SPRAY OPERATORS' TRAINING SCHOOL

SUMMARIES OF PRESENTATIONS

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This training school is presented specifically for commercial applicators of agricultural chemicals by the University of Illinois College of Agriculture, Agricultural Extension Service, and Illinois Natural History Survey, but is open to all persons involved in the handling of agricultural chemicals. This school promotes the proper, timely and wise use of agricultural chemicals. We gratefully acknowledge the assistance of officers of the Illinois Association of Aerial Applicators and the Agricultural Spraying Association in planning the program. Abstracts in this manual bring to you the latest research information, but do not constitute positive recommendation unless so stated. Statements made herein are the responsibility of either the speaker or the institution he represents.

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WEED CONTROL IN SOYBEANS

F. W. Slife

The acreage devoted to soybeans in Illinois jumped to over five million in 1957. With this expansion has come an added weed-control problem. Many of these new soybean acres were formerly land that the farmer considered too weedy to grow soybeans. But with acreage restrictions on other crops, he necessarily has had to put soybeans where they are meeting with some serious weed problems. This in turn has brought more requests than ever before for information about controlling weeds in soybeans.

The few data that are available indicate that weeds reduce soybean yields as much as 10 percent a year and, if the weed is giant foxtail, the reduction may be 25 percent or more. This means that, if good chemicals are ever developed for use on soybeans, there should be a real interest in them and a real need for them. Unfortunately, fewer chemicals have been developed for use on soybeans than on corn, and very few are available today that will consistently produce good results.

Our standard recommendation for controlling weeds in soybeans has been to use cultural means. The seedbed should be prepared early and as many weeds destroyed as possible by shallow tillage. But the soybeans should be planted late enough to permit them to germinate rapidly in the warm soil and to make early growth. This procedure will ordinarily control weeds if early cultivation procedures are followed. In years when rainfall interferes with these operations, however, the fields are extremely weedy. A good, effective, cheap chemical would, in one sense, provide good assurance of controlling weeds regardless of the weather.

Little farm use has been made of the three older pre-emergence chemicals available for soybeans. These chemicals are dinitro, CIPC, and Alanap. The three are similar in that they work under ideal conditions, but are subject to failure when dry weather follows application. In addition, soybeans have little natural tolerance to any of these chemicals, and stands may be reduced when heavy rains follow heavy applications. To insure good results, all three should be used at six pounds of acid per acre on our heavier soils. Both CIPC and Alanap at these rates will give reasonable control of broadleaf weeds and annual grasses, but the dinitro will be much less effective against grasses than against broadleaf weeds.

We will still recommend these chemicals for use on a trial basis, but not for large-scale field use until they have been tried for at least a year under the local conditions.

The only new pre-emergence chemical is Randox, which is now widely available. It is for specific use on annual grasses, which include all of the foxtails, crabgrass, and barnyard grass. It is highly specific for giant foxtail. Since it has been more stable than others under varying weather and soybeans have a good natural tolerance to it, we recommend it for wide use where grasses are the major problem. However, if the field is equally infested with grasses and broadleaf weeds, Randox will be of little use. At present it is quite expensive, necessitating band application, and it is extremely irritating to handle. However, the latter difficulty can be largely overcome by care in handling. Unfortunately, the new herbicides, such as Simazin and EPTC, offer little possibility for controlling weeds in soybeans.

After soybeans have emerged, there is little possibility of using chemicals to control weeds. To control a few of the serious bottomland weeds, such as cockleburs and annual morning glories, it is possible to use 2,4-D at slightly over 1/16 pound of acid per acre in the amine form. But we strongly recommend that this treatment be confined to bottomland areas where, if it is not used, soybean yields are frequently cut in half. On normal upland soils it offers little possibilities because bean yield will be reduced when the weed problem is not severe.

Early post-emergence treatment with dinitro is being continued and offers some possibilities. Rates as low as two quarts an acre when soybeans are first emerging have given control of both broadleaf weeds and grasses. However, no recommendation is being made for use of this treatment until more data are available. Since soybeans will tolerate dinitro only when they are coming through the ground, the dinitro can be applied only during this period; if it should rain at this time, then it would be too late to treat. In addition, the response of weeds to dinitro varies greatly with temperature, being most effective when temperatures are high and least effective when they are low. This treatment does offer promise, however, of being economical and quite effective against the weeds that are commonly found in bean fields.

SORGHUM INSECTS AND CONTROL RESULTS, 1957

W. H. Luckmann

Grain sorghum was a new crop to many farmers in Illinois in 1957, and it may be planted more extensively in the Corn Belt in 1958. There are two types of sorghum: the short, dwarf type used for grain and known as grain sorghum, and forage sorghum, used for silage. This report deals only with insects in grain sorghum.

Biology: Insects were collected at Urbana, Vandalia, Sesser, and Ware to ascertain relative abundance and distribution in Illinois of some of the insects known or suspected to be destructive to grain sorghum. Data on these collections are presented in Table 1. In addition, many other insects were collected from heads of sorghum, including numerous mold-feeding and smut-feeding beetles.

The first seven insects listed in Table 1 can be considered destructive or potentially destructive to grain sorghums in Illinois. Of these, the corn earworm, sorghum webworm, European corn borer, corn leaf aphid, and chinch bug actually caused some damage in 1956 or 1957. However, the distribution and abundance of these pests in central and southern Illinois and the published information concerning them indicate that not all will be pests throughout the sorghum-growing areas of Illinois. Some may be damaging only in specific areas at certain times and in some years. For example, corn leaf aphids and corn earworms could be a problem every year throughout the sorghum areas of Illinois. Chinch bugs and European corn borers could be a problem in some years in specific areas. Although sorghum midges were not collected in Illinois in 1957, published data indicate that their range extends into southern Illinois.

Control: On September 13 seven insecticides were sprayed on the heads of grain sorghum in a field at Ware, Illinois. This field, which was planted in mid-June, was chosen because it contained populations of both sorghum webworm and corn ear worm, but neither insect was present in large numbers. The materials were applied at the dosages indicated in Table 2 at a rate of 15 gallons of finished spray per acre.

Results of the test indicate that several materials were effective against the sorghum webworm and several were effective against the corn earworm, but DDT at 1.5 pounds per acre and phosdrin at $\frac{1}{4}$ and $\frac{1}{2}$ pound per acre were the only materials having observed values that were significantly different for both insects. The values of phosdrin at $\frac{1}{4}$ and $\frac{1}{2}$ pound per acre did not differ significantly.

On the basis of this test and on the basis of reports from other states conducting insecticide studies on sorghum insects, phosdrin appears to be the best insecticide approved for use on some of the common insects infesting heads of grain sorghum.

Table 1.--Important Insects Obtained in Collections Made in Grain Sorghum at Several Locations in Illinois During 1957

Insects	Location at which collected and relative abundance at each location			
	Urbana	Vandalia	Sesser	Ware
Heliothis zea - corn earworm	3	3	3	2
Celama sorghiella - sorghum webworm	5	1	1	1
Pyrausta nubilalis - European corn borer	4	4	5	3
Rhopalosiphum maidis - corn leaf aphid	1	4	4	4
Blissus leucopterus - chinch bug	3	4	4	4
Laphygma frugiperda - fall armyworm	N	N	N	5
Contarinia sorghicola - sorghum midge	N	N	N	N 1/
Lygus lineolaris - tarnished plant bug	1	3	3	3
Adelphocoris rapidus - rapid plant bug	3	4	4	4
Adelphocoris lineolatus - alfalfa plant bug	3	4	4	4

Code: 1 - abundant
2 -
3 - moderate
4 -
5 - occasional specimen
N - none

1/ Sorghum midges reared from heads collected on October 11 approximately 15 miles due west of Cairo, Illinois, on Highway 60 in southeast Missouri. Midges were not reared from sorghum heads collected at Mounds and Ware, Illinois. A few heads appearing to be slightly damaged by midge were collected in Illinois, but no specimens were reared from these heads.

Table 2.--Effectiveness of Several Insecticides Sprayed on Heads of Grain Sorghum for Control of Sorghum Webworm and Corn Earworm

		Number of live sorghum webworms and corn earworms in 10 heads			
		24 hours after application		7 days after application	
Insecticide	Dosage (lb./acre)	Sorghum webworm	Corn earworm	Sorghum webworm	Corn earworm
DDT	1.5	4	1	2	0
Heptachlor	0.5	21	2	10	2
Malathion	1.0	11	7	12	5
Methoxychlor	2.0	1	11	0	7
Parathion	0.5	6	10	4	3
Phosdrin	0.25	0	2	1	3
Phosdrin	0.50	0	0	1	3
RE-4355 1/	0.50	6	11	6	6
RE-4355 1/	1.00	3	4	5	4
No treatment		20	10	13	7

1/ California Spray Chemical Company experimental compound.

NEW HERBICIDES

F. W. Slife

The following new chemicals are in the experimental stage and may be available within the next few years for weed control. The information given is based on research work done at this station, as well as at other stations throughout the Midwest.

Randox T is a pre-emergence chemical to control annual grasses in corn and certain horticultural crops. Beans, and particularly soybeans, have very little tolerance to it. Randox T is very similar to Randox except that a new compound has been added to it to improve control of broadleaf weeds. This new compound, however, is toxic to soybeans. In 1957, Randox T controlled both broadleaf weeds and grasses for a period of six weeks. Although it is highly irritating and it will be rather expensive at the beginning, we believe that it will replace the mixture of Randox and 2,4-D used rather widely in 1957. The combination of 2,4-D and Randox has caused some slight injury to corn.

Simazin is a pre-emergence chemical that was first evaluated in 1956 and rather widely tested in 1957. Corn appears to have a great deal of tolerance to this chemical. At two pounds per acre it seems to control all broadleaf weeds and annual grasses commonly found in cornfields of the corn-belt area. All bean crops, including soybeans, seem to be sensitive to it. Simazin is a wettable powder. It is not irritating or toxic to handle. When applied at two pounds per acre, it usually controls weeds all season long. Simazin is not being recommended for use in 1958 until more thorough studies have been made concerning soil residues. Because it remains in the soil for a rather long time, there is some possibility that it could be carried over into the next growing season.

EPTC is also a new pre-emergence compound that was evaluated rather thoroughly in 1957. When this chemical is incorporated into the seedbed by disking or harrowing, it gives much better results than surface applications. Unfortunately, incorporation in the seedbed reduces the tolerance of certain crops to the chemical and is quite injurious to soybeans. Four pounds incorporated may slightly injure corn, but it has completely controlled weeds for six weeks. EPTC may have a very important place in controlling Johnson grass seedlings, which seem to be sensitive to the chemical. No recommendations will be made for use of EPTC for controlling weeds in corn until further information is available.

Vapam is a new soil fumigant that gives good control of diseases and weed seeds. Like other soil fumigants, it is expensive and must necessarily be used on either high-profit crops or in special areas, such as lawns and gardens. Its advantage over some of the other soil fumigants is that no tarpaulin is required and it can be applied directly to the soil.

Mylone is another new soil fumigant that has about the same properties as Vapam. Again, no tarpaulin or plastic cover is required to apply this material, and control of weed seeds has been good.

NEW INSECTICIDES FOR LIVESTOCK INSECTS

Steve Moore

Systemics

1. Dow ET-57 is an organic phosphate with an LD 50 of 400-500 mg./kg. for rats. This material is approved for use as a grub control remedy for cattle. It should be applied as a bolus or drench at the rate of 15 grams for every 300 pounds of animal body weight. One application after heel fly activity ceases but before the grubs appear in the back is recommended (September - December). Allow 60 days to elapse between treatment and slaughter. The material will be available to a limited extent in sections of Iowa, Nebraska, Wyoming, and South Dakota in 1958. It shows promise as a toxicant for control of chicken lice and nasal bot flies of sheep, and as a toxicant in baits for control of houseflies.

2. Bayers 21-199 (Chemagro Corp.) is an organic phosphate that is effective against cattle grubs when applied as a 0.25% spray at the rate of $1\frac{1}{2}$ gallons per animal prior to grub appearance, but after cessation of heel fly activity. Oral dosages of 25 mg./kg. do not control as well as the spray applications, and they cause toxic symptoms among the cattle. Even though the spray dosage is 50 mg./kg., it is not injurious to cattle. It is also effective against screw worms in sheep and horn flies on cattle and as a toxicant in baits for housefly control. However, this material is not approved for use at present.

3. Cyanamid 12880 is an organic phosphate. It is effective against cattle grubs when applied either orally or intermuscularly at 10-15 mg./kg. A 40-60 mg./kg. dosage produces severe toxic symptoms in the animals. It is not approved for this use at present.

Contact Residual Insecticides

1. Chlorothion, or Bayers 22-190, is an organic phosphate with an LD 50 for rats of 1500 mg./kg. It is being formulated as a 25% wettable powder, a 50% emulsion concentrate, and a 3% dust. It is effective and approved for use as a residual spray against houseflies at 0.5 to 1.0% and also as a bait toxicant for houseflies. Chlorothion may be used in dairy barns. Its effectiveness is between that of malathion and diazinon. It also appears promising against cattle grubs and has a wide range of effectiveness similar to that of parathion on fruit, vegetable, cotton, ornamental, and household insect pests.

2. Korlan, or Dow ET - 14, is an organic phosphate with an LD 50 of 1700 to 1740 mg./kg. for rats. It is formulated as a 25% wettable powder, 25% emulsion concentrate, 44% emulsion concentrate, 5% dust, 5% granules, and 7% oil solution. It is effective and approved for use against houseflies as a 1% suspension. Its effectiveness is comparable with that of diazinon. Korlan may be used in dairy barns. It is also effective as a bait toxicant and on treated cord. It shows promise against biting flies, chicken ecto-parasites, mosquitoes, ticks, chiggers, household pests, and bedbugs.

3. Dicapthon, or Cyanamid 1424, is an organic phosphate with a LD 50 of 500 to 1700 mg./kg. for rats. It is being formulated as a 50% wettable powder, 4% dust, and 25% emulsion concentrate. In laboratory effectiveness against houseflies

it is comparable with diazinon. Field work has shown it to be effective as a residual spray at the 1% level and as a bait toxicant. However, it is not approved for this use at present. It also shows promise against brown dog ticks, cockroaches, fleas, bedbugs, and mosquitoes.

4. Compound GC 1189 (General Chemical Division, Allied Food and Dye Corp.) is a chlorinated hydrocarbon with an LD 50 of 50 mg./kg. for rats. It is being formulated as a 50% wettable powder. It shows promise against houseflies, acting chiefly as a stomach poison with a slow knock-down and long residual action. In addition, it has some fungicidal properties. It is not approved for use at present.

Repellents

1. Tabutrex, or di-n-butyl succinate (Glen Chemical Co.), is a repellent with an LD 50 of 8000 mg./kg. for rats. It is effective and approved for use against horseflies, stable flies, and houseflies. It may be applied to dairy and beef cattle, horses, and pigs at the rate of one quart of 1 to 2% water-diluted emulsion spray. At the 2% level this material will give protection for three or four days. It is superior to pyrethrin.

2. MGK R-326, or di-n-propyl isocinchomeronate (McLaughlin, Gormley, King), is a repellent that is comparable to tabutrex and is effective and approved for use against biting flies. It is recommended as a 2% spray and has an LD 50 of over 5000 mg./kg. for rats. However, this material is more subject to degradation at high moisture conditions than is tabutrex. It is superior to pyrethrin.

3. DET, or diethyltolumide (Hercules Powder Corp.), is a repellent with an LD 50 of 2000 mg./kg. for rats. It is effective against mosquitoes, chiggers, fleas, and biting flies. However, it has a low tolerance to moisture, which reduces its effectiveness considerably when applied to farm animals. It is superior to the above-mentioned materials against mosquitoes but somewhat less effective against flies. Dosages of 50 to 70% of the meta isomer may be used directly on the person. It is available and approved for use.

NEW INSECTICIDES FOR USE ON PLANTS

Norman Gannon

During the past few years, most of the emphasis in development of new insecticides seems to have been on the group known as organic phosphates. Of this group, the systemics have attracted the most attention. True systemics are taken up by the plant, either through the foliage or through the roots, and are translocated throughout the plant as such or are converted to other materials that are toxic to insects. Some of them have been widely tested as seed treatments with encouraging results. The treatment of seed to protect it and the young plant from insect attack can have many advantages over other methods of insecticide application. Among these advantages are modest cost of treatment, ease of application, possible elimination of several early treatments by conventional means, and increased safety to the farmer or applicator through lessened exposure to materials that quite often exhibit considerable toxicity to mammals as well as insects.

New insecticides which are available on either a commercial or limited commercial basis for use on plants are as follows:

Systox or Demeton, available through Bayer, Chemagro, or Pittsburgh Chemical, while not strictly new, is one of the more important commercially available systemics. It has had considerable usage in the control of aphids and mites on apples, pears, strawberries, and muskmelons as well as on aphids and leafhoppers on potatoes, cabbage, cauliflower, Brussels sprouts, and broccoli. Treatments should be made at least 21 days before harvest. It has also been investigated widely as a seed treatment.

Thimet (American Cyanamid 3911) is a systemic that is generally effective against mites, aphids, and leafhoppers. Foliage applications have given good control of cabbage aphids, but with little residual effectiveness. As a foliage spray. Thimet has also given good control of the Mexican bean beetle and has certain merit as a seed treatment. It has been registered recently for use on alfalfa and sugar beets.

Phosdrin (Shell - OS-2046) is a water-miscible systemic with a considerable amount of fumigant action. Because of rapid hydrolysis of the isomers, it can be used on leafy crops to control mites and aphids within three or four days of harvest.

Tetram (Chipman R-6199), a highly active and persistent systemic, has controlled citrus red mite for more than six months. It shows promise in controlling scale insects on deciduous fruits and aphids and mites on deciduous fruits, cotton, alfalfa, etc.

Trithion (Stauffer R-1303) is a non-systemic organic phosphate with relatively long residual action. It appears to be effective against a wide range of insect and mite species.

Guthion (Chemagro or Bayer 17147), compared with most other organic phosphates, is fairly residual. It is registered on cotton for control of boll weevil, aphids, mites, leafhoppers, leafworms, etc., but shows many other possibilities.

Dylox (Chemagro or Bayer L13/59) presently is sold as Dipterex, a sugar bait material for fly control. It appears to have promise in controlling many other insects and is fairly safe to warm-blooded animals.

Other promising insecticides that have been available primarily for research purposes thus far are as follows:

American Cyanamid 4124, 12008, and 12009, Chlorthion (Chemagro or Bayer 22/190), Di-Syston (Chemagro or Bayer 19639), Korlan (Dow-ET-14), Isolan (Geigy 23611), Pyrazoxon (Geigy 24483), Hercules AC-528, Niagara Thiodan, Nialite (Niagara 1240), Phostex (Niagara 1137), Isopestox (Pest Control, Ltd.), and Sevin (Union Carbide 7744).

CONTROL OF CANADA THISTLE

Earl C. Spurrier

Canada thistle, a primary noxious weed in Illinois, is a serious weed pest in many Illinois crop fields. It is a perennial, propagating by both seeds and root parts. It is a cross-pollinated plant, with the male and female flowers in separate heads and borne on different plants. The seeds are blown by wind currents for great distances. The roots often grow two to three feet deep and a network of cross and lateral roots extends in all directions below plow depth. New shoots are sent up from the underground root system--thus the occurrence of patches of Canada thistles.

Patches of thistles found in cultivated fields are a source of infestation even though seeds are not allowed to form. Plowing, harrowing, and cultivation often start new patches by carrying root portions to uninfested areas in the field. Small patches should be isolated by tillage until they can be destroyed by chemical means.

Canada thistles spread from field to field and from farm to farm by windblown seeds, as well as in weed-seed-infested crop seeds, hay, and straw. It is therefore necessary to destroy all plants before they produce mature seeds and to use extreme precautions to prevent movement of these weed seeds in harvested crop seeds, hay, and straw.

Chemical Control - Two chemicals are recommended for controlling Canada thistles. They are (1) 2,4-D (2,4-dichlorophenoxy acetic acid) and (2) amino triazole (3-amino-1, 2, 4 triazole). The 2,4-D is somewhat cheaper per treatment to apply and can be used as a selective-type herbicide in crop fields to reduce weed seed production. However, some strains of thistles are resistant to 2,4-D. The amino triazole is somewhat more costly per treatment and is non-selective, but it is far superior to 2,4-D for killing thistles.

Spot treatments with 2,4-D can be used in some crops at the rate of 1/2 to 1 pound of acid in 10 to 15 gallons of water per acre. The ester formulation is preferred. Best results are obtained if 2,4-D is applied when plants range from 12 inches high to early bud stage. Treatments will have to be repeated each year for several years to successfully eradicate susceptible strains. Rates exceeding 1 pound per acre can cause too rapid top kills and thus reduce effective root destruction. Lower rates need to be applied in small grain fields after the grain tillers but before it enters the boot stage. This treatment may somewhat reduce yield, but it will also reduce Canada thistle seed production. After the grain is harvested, clip the stubble and treat the regrowth when it is 6 inches tall, with more 2,4-D or, better yet, with amino triazole.

Amino triazole, a new herbicide, is now available to use in controlling Canada thistle. Apply amino triazole to actively growing thistles in the spring when they are at least 12 inches high, but before budding begins. If thistles are mature, clip, and spray regrowth when it is 6 inches tall. As a broadcast spray, apply 8 pounds (4 pounds of actual amino triazole) in 30 to 40 gallons of water per acre. Thorough wetting of the thistle foliage is necessary. If you use a hand gun, you may need to use more water per acre. If you use a small tank (3-gallon) hand sprayer, apply 10 level tablespoons in one gallon of water or 1 pound in 6 gallons of water, and spray until thistles are thoroughly wet. Amino triazole is toxic to other crop plants and should be used as a spot treatment in crop fields. Don't disturb the treated thistles for at least two weeks after treatment.

Amino triazole has been tested as a pre-planting treatment for thistle-infested fields to be planted to corn. Eight pounds (4 pounds of actual ATA) were broadcast in 20 gallons of water per acre early in the spring when the thistles were 6 to 10 inches tall. Two weeks later the areas were plowed or disked, the seedbed prepared, and the corn planted. This treatment substantially reduced the thistle stands with no damage to the corn. In this case, don't disturb the thistles before chemical treatment, as early spring growth may be retarded and thus delay both the treatment and the planting date of corn.

Amino triazole acts slowly. Five to six days after treatment, the plants begin to turn yellow and then white. Top growth will usually die in two to three weeks. New growth may appear from roots, but it is generally chlorotic also. If normal growth reappears, it should be resprayed. This growth could originate from newly germinated seeds or from root extensions that were not completely killed by treatment.

Maximum use of 2,4-D will greatly reduce thistle infestations on many areas. However, in many field tests conducted in cooperation with the Agronomy Department of the University of Illinois, amino triazole has consistently reduced stands of thistles by 90 percent or more and in many cases has given complete kills, with little or no regrowth. It is easy to apply and appears to be a very satisfactory herbicide for controlling Canada thistle, provided, of course, reinfestation is prevented from other sources.

DEVELOPMENTS IN STORED GRAIN INSECT CONTROL

Steve Moore

Development of new and improved chemical control materials, coupled with use of flat structures for commercial storage, presents a good opportunity for custom spray operators in the field of stored grain insect control. Many of the new flat storage structures for grain have aeration equipment or lend themselves readily to fan installations that make it possible to apply a gaseous fumigant like methyl bromide safely and at reduced dosages. The recent approval of malathion as a bin spray and for direct application to grain makes possible improved control at low cost. A custom spray applicator can now apply control materials and show a good margin of profit at a price equivalent to what it would cost the customer to buy material and do the job himself.

Fundamental Principles for Controlling Stored Grain Insects

1. Practice good sanitation.

2. Follow clean-up with a bin spray material like 1.0 - 1.5% malathion or 2.5% methoxychlor or TDE.

3. Store grain that is low in moisture, foreign material, and temperature to help prevent attack by grain insects.

Treatment of the Grain

1. Preventive treatment for clean grain dried to a safe moisture level

   a. Malathion

      Liquid - 5 gallons of .78% per 1,000 bushels equals 5.2 p.p.m.
      To mix, add ½ pint of 57% emulsion concentrate to 5 gallons of water.

      Dust - 40 pounds of .75% dust per 1,000 bushels equals 5.0 p.p.m.

   b. Pyrethrins are also available as both liquid and dust protectants, but in wheat treatment tests in Illinois malathion was superior, especially against surface-feeding meal moths.

2. Control Treatment

   a. Liquid fumigants applied to surface - there are numerous liquid fumigants that are effective. However, in flat storage structures a higher than normal dosage is required, and the hazards to the applicator are great.

   b. Gaseous fumigant- methyl bromide

      (1) Without forced distribution, apply to tightly sealed head space at the rate of 3 pounds per 1,000 cubic feet.

      (2) With forced distribution, seal the head space and apply into the fan at the rate of 1 pound per 1,000 cubic feet. Continue to push the fumigant up through the grain until it reaches the surface in sufficient concentration. Stop fan and let fumigant settle back down

through the grain. A minimum air flow of .02 cubic foot per minute per bushel is required.

(3) With recirculation, install a return duct to the fan. Apply 1 pound per 1,000 cubic feet and recirculate only as long as it takes to get good distribution. A minimum air flow of 0.1 cubic foot per minute per bushel is necessary.

One of the greatest problems in commercial storages, especially the new flat-type structures, is surface-feeding meal moths. A 1.0 to 1.5% malathion spray treatment will give excellent control. At most, only two applications are needed during a season. A pyrethrin spray at 0.5% is also effective, but repeated applications are required. At the time the grain surface is being treated, the bin above the grain surface should also be liberally sprayed. Mineral oil may be used on the surface of shelled corn at the rate of 2 quarts per 100 square feet. If the oil film is broken, retreatment will be necessary. Where infestations involve insects other than the surface-feeding meal moths, a fumigant application is recommended.

Precautions

Always read the labels on containers carefully, and follow directions. All fumigants are extremely dangerous. Some that we consider relatively safe from the acute standpoint (carbon tetrachloride) can have serious chronic effects. Still others are extremely dangerous from the acute standpoint (HCN) but have no chronic effects. Chronic effects include injury to vital organs like the liver, kidneys, and lungs. Many fumigants have a restricted usage and will damage certain articles, products, plants, seeds, etc., if used on them. Be sure to know the limitations of the material you are using.

The method of application itself will increase or decrease the hazards involved with a particular fumigant. The following table is a good illustration:

	Concentration in p.p.m.		
Method of application	Carbon disulfide	Ethelene dichloride plus carbon tetrachloride	Ethylene dibromide
Pouring from can	900	900	30
Pouring from sprinkling can	2000	2100	90
Knapsack sprayer (without nozzle)	3300	4700	90
Applying from outside with sprayer	1700	1600	60
In bin after treatment	10000	10000	125

Avoid Residue Problems

To avoid residue problems, use chemicals wisely and according to the manufacturer's labels. The table on page 15 lists the tolerances and exemptions from tolerances for pesticide chemicals used on stored grain.

Chemical	Allowable residue, p.p.m.
Calcium cyanide	25
Carbon disulfide	Exempt
Carbon tetrachloride	Exempt
Chloropicrin	Exempt
Ethylene dibromide	50
Ethylene dichloride	Exempt
Hydrogen cyanide	25
Malathion	8
Methoxychlor	2
Methyl bromide	50
Mineral oil	Exempt
Piperonyl butoxide	20
Pyrethrins	3
Sulfur dioxide	Exempt
TDE	No residue

NEMATODES IN ILLINOIS

M. B. Linford

Fields, orchards, pastures, lawns, and gardens in Illinois contain a wide assortment of species of plant-parasitic nematodes representing over a dozen genera. Rarely do we examine a sample without finding one or more such species. In greenhouses, nematode injury may be as severe in Illinois as elsewhere. In the open, however, conspicuous crop losses from nematodes occur much less frequently here than in many other parts of the country. Our general picture seems to be one of widespread but generally mild infestations that doubtless are reducing yields somewhat, but rarely enough to justify the application of expensive control measures.

All the plant-parasitic nematodes are worm-like in form, at least in the immature stages, and most of them are so small that they can be recognized only with a microscope. An exceptionally large one that we find in rose greenhouses may measure 1/6 inch long. The cyst nematodes and the root-knot nematodes, in the adult female stage, become lemon-shaped to balloon-shaped and are barely large enough to see without magnification.

Nematodes can be active only in the presence of moisture. When they dry out, some kinds are killed immediately but others become more tolerant of heat and chemicals than when moist and active. Dependence upon moisture prevents nematodes from feeding as ectoparasites on exposed surfaces of leaves and stems, but there are several important kinds that feed internally in aerial parts, and others that thrive as ectoparasites in the growing buds of plants, where they are protected from drying.

The vast majority of plant-parasitic nematodes feed on or in roots. Some cause root galls that enclose the parasites; some cause gall-like swellings, although the nematodes lie in the soil and feed from the root surface; some change the internal structure and the function of roots so that they serve the parasites instead of the plant; some kill invaded tissue, causing symptoms much like those of root rots caused by fungi; and some others seem to cause only reduced growth and altered physiology of the plant.

In general, nematode injury to roots is readily overlooked or wrongly diagnosed, the effects on top growth being mistaken for those of drought, malnutrition, or diseases caused by other agents. Diagnosis usually requires laboratory examination, and even this can be inconclusive, because we are short of information as to what population densities of various kinds of nematodes are required to cause serious injury to different crops. Furthermore, numerous species of nematodes are still of undetermined significance.

Our relative freedom from serious nematode troubles seems to be the combined result of several factors. The widespread practice of crop rotation is perhaps of first importance, because nematodes tend to become most destructive in intensive or one-crop agriculture. Our prevailingly heavy soils limit some but not other kinds of nematodes. In much of Illinois, winters seem to be too severe for the survival of certain warm-climate species, although other species survive freely much farther north. Certain nematodes that attack aerial parts of plants thrive best where light showers, wet fogs, or heavy dews are frequent, and they find our climate unfavorable. The fact that our most important crops are grown from seed has helped to delay introduction of many nematodes because shipment of nursery stock and other vegetative propagating material is a major means of dissemination. In part, however, our favorable position today results from chance alone, in that certain nematodes that might be destructive here simply have not been introduced or become established.

We have found instances of severe nematode injury in Illinois that warn of possible future troubles. Only a few can be mentioned. Tomato transplants set out from infested greenhouses have suffered severe root knot, and greenhouse infestations of this and other nematodes are frequent where soil sterilization and sanitation have been neglected. Mushroom growers who have poor sanitary arrangements or who fail to heat their houses sufficiently after filling for a new crop have experienced poor crops from nematodes feeding on the mushroom spawn.

Local infestations of the bulb nematode in onion set fields of south Cook County caused more losses to bulb growers in New York who planted the sets than to the Illinois set growers. This infestation has been reduced so greatly by crop rotation that no infested sets have been found during the last three seasons. Very severe root knot has occurred in nearly pure sand near Edwardsville. Control by soil fumigation was highly successful in the melon field, but similar fumigation in a nearby melon field where there was only a trace of root knot did not significantly increase plant growth. In many gardens and some strawberry fields and orchards, various kinds of nematodes have been sufficiently abundant that they probably were limiting growth. In some of them, chemical control might prove feasible.

Control with existing nematocides and present methods of applying them cannot be recommended for Illinois' most important crops in our predominantly heavy soils. Heavy soils are very difficult to fumigate effectively, regardless of cost, and costs are generally prohibitive even on light soils for use with crops of low acre value. Pending important new developments in chemical control, we must rely chiefly on such means as crop rotation, resistant crop varieties, and biological control. Recent reports from North Carolina, for example, indicate that certain non-economic strains of soybean have been found to be highly resistant to the soybean cyst nematode. This should make possible the breeding of resistant varieties suited to our needs before this nematode becomes widely established in Illinois.

From various observations in Illinois it is clear that we now receive the benefits of a very material degree of natural biological control. We are trying to learn the major components of the biological complex involved and to learn how best to retain and increase its effectiveness. Nematodes can be killed by a great many living things in soil: by fungi that act as internal parasites and fungi that capture nematodes in specialized traps and then consume them; by mites and other small arthropods; and by predaceous nematodes of several distinct types that feed voraciously on other nematodes.

We are especially interested in the predaceous nematodes. Under laboratory conditions, some of them have phenomenal capacity to destroy other nematodes and, when food is abundant, they can multiply over 1000-fold in two weeks. We have several species of this type in Illinois. In the laboratory we are learning how best to culture them and are trying to select the most promising species for tests of effectiveness in soil. We know less about predaceous nematodes of another group, but one of our students is now finding them widespread in Illinois and is trying to learn how best to culture them and to determine their usefulness.

We make no promise of achieving better biological control than now prevails in some fields, but we are hopeful. Much experience here and elsewhere indicates that, where conditions are extremely favorable to the plant parasites and where soil fumigation affords an economically feasible means of control, biological control does not do enough. We think, however, that it merits the fullest consideration under Illinois conditions.

EFFECT OF GIANT FOXTAIL ON YIELDS OF SOYBEANS AND CORN

J. W. Pendleton

Weeds reduce crop yields by competing for the essentials of growth--namely, moisture, light, and nutrients. It has generally been assumed that, if it were possible to supply all of these essentials of growth adequately, weeds would not reduce yields. This would be difficult to do, and particularly in terms of water. We know that many weeds require as much water per acre as crops and, since year in and year out water is our limiting factor in crop production, it would be extremely difficult to supply enough water for both weeds and crops unless we had a source of water to irrigate with.

Few figures are available on how much weeds reduce crop yields. We would expect it to vary with climatic conditions, as well as with the soils on which the investigation is carried out. Some recent work from Iowa indicates that in average years soybean yields are reduced about 10 percent by reasonably light infestations of weeds. The same yield reduction has been recorded for corn. Ellery Knake of the Department of Agronomy here at Illinois decided to study this problem further. He was particularly interested in giant foxtail, which is the major problem in our corn and soybean area here in central Illinois.

Both corn and soybeans were planted in an area known to be heavily infested with giant foxtail. Corn was planted at the rate of 16,000 plants per acre, and soybeans were drilled in 40-inch rows at the rate of one bushel per acre. All plots received three cultivations so that the middles of the rows were kept clean, but the giant foxtail plants were thinned to different stands in the corn and soybean rows. The heaviest infestation of foxtail for both corn and soybeans was a three-inch band left directly over the row. Foxtail germinated and grew to a stand of approximately 70 plants per running foot of row. The other stands of foxtail studied in this experiment were one plant every inch, one every two inches, one every four inches, one every 12 inches, and one every 24 inches.

The soils on which this investigation was carried out was a heavy, black clay loam known to be high in fertility. All of the corn plots received 80 pounds of nitrogen in the form of anhydrous ammonia when the corn was about 18 inches tall, and the soybeans received no fertility treatments. Yields of both corn and soybeans from the different stands of foxtail are listed below:

Yield Reductions Caused by Giant Foxtail in Corn and Soybeans

Foxtail stand	Corn yield bu/A*	Soybean yield bu/A**
3-inch band over row	74.3	26.0
1 plant every inch	86.6	35.9
1 " " 2 inches	89.5	39.5
1 " " 4 "	93.5	40.4
1 " " 12 "	95.0	41.6
1 " " 24 "	98.1	42.3
Check - no foxtail	100.0	43.1

* Converted to 15.5% moisture.
** " 12% " .

These yields have not as yet been analyzed for statistical significance, but there is a very definite trend toward decreasing yields with increasing stands of foxtail. Climatic conditions were almost ideal this year for growth of both corn and soybeans. Although these plots were not planted until the first of June, they received above-normal rainfall throughout the growing season--so much that it would not seem possible that moisture was the limiting factor. In corn, with adequate moisture and 80 pounds of supplemental nitrogen, there was still a rather severe decrease in yield with the increasing stand of foxtail. It seems likely that the yield reductions from the same stands of foxtail might be even more severe under different environmental conditions. If rain should occur immediately or soon after planting and establish the foxtail, then lower rainfall than normal during the summer might mean that yields would be reduced even more than under the above-stated conditions.

This particular experiment will run for three years so that some of the climatic variables can be studied further. This work indicates that, if farms are heavily infested with giant foxtail or other annual grasses, applications of some of our present known chemicals would mean a tremendous saving to the farmer. Even though they might not completely eliminate the foxtail, reducing the stand 90 to 95 percent would probably prevent much of its competition with the crop and more than pay for the use of the chemical.

LIQUID FERTILIZERS

S. R. Aldrich

Liquid fertilizers have come into the picture rapidly in recent years. The relative place for liquid and dry fertilizers in Illinois depends upon:

1. Agronomic consideration
2. Economic consideration
3. Suitable equipment

Suitable equipment is primarily the concern of agricultural engineers. The economics of liquid versus dry fertilizers is best known to those in the fertilizer industry who have made and merchandised both. My comments will therefore be limited to the agronomic considerations.

Rate of Availability

Some people have wondered whether liquid fertilizers, being already in solution, are more quickly available to plants than dry fertilizers, especially during drouth periods. The consensus of agronomists is that there is no difference between the two. In moist soil the nitrogen, potassium, and water-soluble phosphorus go into solution within a matter of hours. In an air-dry soil the small amount of water applied with the fertilizer would not make the fertilizer more effective than dry fertilizer, which is deliquescent and would soon become moist. In a very dry soil the plant roots would not effectively take up nutrients from either liquid or dry fertilizers.

Water Solubility of the Phosphorus Source

The phosphorus source in liquid fertilizers is all water soluble. In dry mixed fertilizers it varies from high to low, with most formulations in the intermediate range. High water solubility is most likely to be important for band applications (starter) of small amounts of phosphorus on alkaline soils that are low in phosphorus. It may be important in starter fertilizer for wheat, although research on this subject is meager. These conditions are not typical in Illinois. It seems doubtful that water solubility higher than that commonly found in mixed fertilizers is necessary for most situations where fertilizers are used in Illinois.

Water solubility is not an advantage for broadcast applications. There is a possibility that it would be a disadvantage on acid soils because of greater "fixation."

Differences in water solubility probably persist for only a few weeks at most.

Ordinary 20% superphosphate and triple superphosphate (45%) are highly water soluble.

"Available" and "water soluble" do not mean the same thing. "Available" phosphorus is by definition the amount that is soluble in a standard solution (ammonium citrate) under specified conditions. (Part or all of the "available" phosphorus may be soluble in water.)

Limitations on Ratios

With presently available materials, the range of ratios is somewhat more limited in liquid fertilizers than in dry fertilizers.

Liquid Fertilizers Mainly for Maintenance Applications

For the farmer who wants to build up his soil from a low to a medium or high level of phosphorus and potassium, there are more economical sources than liquids. Liquid fertilizers should be directed to those who fertilize on a crop basis or who have reached the "maintenance phase" of their soil fertility program.

Minor Elements

Liquid fertilizers are generally lower in minor elements than dry fertilizers, but this is not considered to be a disadvantage because there are practically no known deficiencies of minor elements for field crops in Illinois. The reason for the lower minor element content is that liquid fertilizers require a phosphoric acid that is higher in purity than the acid used in dry fertilizer manufacture.

Yields

A few states have compared dry and liquid fertilizers. Ohio and Iowa researchers report equal results from the two.

THE PLACE OF GRAVITY FLOW IN LIQUID FERTILIZER APPLICATION

Wendell Bowers

Gravity-flow applicators appear to have a definite place in the future of the liquid fertilizer industry. Their low-cost, simplified design makes them attractive for farmers to own and operate. Despite its simplicity, gravity flow is not without problems. To better understand how to take advantage of gravity-flow equipment, let us review some of the factors relating to behavior of the fertilizer solutions under gravity flow.

I. Types of gravity flow

A. Top vent - The top of the tank is vented to the atmosphere. The pressure head at any given time is equal to the vertical distance between the orifice and the liquid surface in the tank. The pressure head decreases as the tank empties, resulting in a continually changing flow rate.

B. Bottom vent - The tank is sealed except for a small vent tube extending from the bottom of the tank to some point higher than the tank top. The pressure head is equal to the vertical distance between the orifice and the liquid level in the bottom vent tube. Except for the short time it takes to build up a vacuum inside the tank, the head remains constant.

II. Rate of flow

$Q = CAV$

Q = rate of flow

C = coefficient of discharge (varies from .6 to .7)

A = cross-sectional area of orifice

V = velocity of stream through orifice

$V = \sqrt{2\ gh}$ $\qquad g = 32.2$ $\qquad h$ = head of liquid in feet

From the above equations it can be seen that flow rate through a given orifice is proportional to the square root of the head.

III. Characteristics of gravity flow

A. Volumetric flow rates of liquid fertilizer solutions are nearly equal to those for water. Tests conducted in 1956 gave the following results for five orifices ranging in size from .046 inch to .125 inch, final heads ranging from 1 to 5 feet for a tank 2 feet deep.

Solution	Average variation from water percent
21% aqua ammonia	1.6
32% non-pressure nitrogen	1.7
9-9-9	1.3
12-6-6	1.8

B. Falling head tests simulating top-vented conditions with a tank 2 feet deep showed the following:

Final head (to bottom of 2-foot tank), ft.	Percent variation from average	
	Top third	Bottom third
1	+18.4	-14.8
2	+11.8	- 9.7
3	+10.0	- 7.3
4	+ 7.6	- 5.7

These results show tendency for the coefficient of discharge to compensate for the change of head. Differences would be even smaller for a circular tank.

C. Bottom venting provides uniform flow. George Jedlicka, a graduate student, found less than 1% variation in flow as the tank emptied. He also determined that vent size was not a significant factor and that the tank must maintain an air-tight seal.

IV. Restrictions on gravity-flow equipment

A. Use corrosion-resistant equipment throughout.

B. Provide instant shut-off devices.

C. Maintain large-sized lines feeding orifices to eliminate viscosity effect on rate of flow.

D. Use thin, sharp-edged orifice plate to prevent viscosity effect on flow rate.

E. Prevent low points in lines to orifices to eliminate air bubbles.

V. Practical applications for gravity-flow equipment

A. Top-vent systems

1. Can be used where variation in flow rates are within the limits of plant food recommendations.

2. Ideal for high heads with small-diameter tanks.

3. Permit use of less expensive equipment, since no air-tight tank seal is required.

B. Bottom-vent systems

1. Well suited for manufacturers who must meet rigid application requirements as to flow rates.

2. Should be used where accuracy is needed. Example - starter fertilizers or top-dressing small grains.

3. Well suited for customer use.

C. General

1. In level areas the application of gravity-flow principles seems almost unlimited. As new techniques for supply tanks and field transfer are developed, we should see continued expansion in the use of gravity-flow equipment.

2. Gravity flow is widely used in the southeastern United States. They have used it on legumes without excessive crop injury when applied in 10-inch bands.

WEED CONTROL IN CORN

W. O. Scott

Cultivation is still the most important weed-control measure in corn, but chemical weed control has gained a definite place in production of this crop. Thus far 2,4-D is the most important chemical we have for use in corn. It has solved many of our broadleaf weed problems. It is unfortunate that 2,4-D is not being used on more corn acreage in Illinois. With its extremely low cost, many areas in Illinois could gain substantial yield increases by applications of 50 cents' worth of 2,4-D per acre. The amine forms are recommended at 1/2 pound and the volatile esters at 1/4 pound. The low-volatile esters, if they are used on corn, should be used at slightly lower rates than the volatile esters. When the amines and esters are used at recommended rates, the end results will be very similar.

Unfortunately, at the recommended rates, 2,4-D will not control all broadleaf weeds. There is a tendency on the part of some farmers to increase the rate to control the more resistant weeds, such as jimson weed, velvetweed, and smartweed. Increasing the rate of application increases the danger of 2,4-D injury to corn. The injury may or may not be severe, and it may or may not be reflected in yield reductions. Instead of increasing rates, we strongly recommend spraying earlier. Applications should be made as soon as it is seen that weeds have been missed by the cultivator. Then the recommended rates will give good control and consequently cause less damage to the corn. More care is needed in applying 2,4-D. Too many people are applying 2,4-D who do not know how much they are delivering per acre. Sprayers should be calibrated carefully each year.

Because of the increasing problem of grass in corn, grass killers are attracting interest. Randox was used rather widely in 1957 as a pre-emergence treatment in corn. The results were generally favorable. Although this chemical is expensive and irritating to handle, it gives good results if applied carefully and pays dividends in seriously infested areas. Unfortunately, when Randox is mixed with 2,4-D as a pre-emergence treatment, it may cause some injury to the corn. The mixture gives better control of broadleaf weeds than Randox alone. However, the heavy rainfall experienced in the spring of 1957 washed this combination down around the germinating corn seed and caused some injury to the corn. This has not happened when Randox has been used alone. It would seem advisable not to recommend the combination mixture for pre-emergence treatment, but to save the 2,4-D for early post-emergence treatment if necessary.

Simazin shows promise as a pre-emergence herbicide in corn, but more complete evaluation of its residual effects will be necessary before it can be recommended.

REDTOP WEEVIL RESEARCH, 1957

W. H. Luckmann

A weevil species, Centrinaspis capillatus, is sometimes destructive to redtop, particularly in fields grown to produce seed. This weevil has no approved common name, but in this report it is called the redtop weevil.

Occasionally the redtop weevil damages redtop considerably, but the following year it may do little damage. The factors associated with sporadic outbreaks of this pest are not known. In Illinois the weevil caused moderate damage in 1954, minor damage in 1955, extensive damage in 1956, and severe damage in 1957.

A study of the life history of this pest was begun in 1956 in Fayette County and continued during 1957 in adjoining Clay County. Except for one period in the life cycle of this insect, the data and recorded observations obtained in 1956 and 1957 are very consistent.

The redtop weevil apparently has only one generation each year. It overwinters as an adult in the upper few inches of soil and debris in fields of redtop. The weevils begin to leave hibernation in early May and feed on the leaves and stems of the crop. The adults mate frequently and females begin laying eggs during the last half of May. A single round egg is inserted into the hollow center of an internode of a redtop stem. Some egg-laying may continue until early July. The peak adult population occurred during the first 7 to 10 days of June in 1956 and 1957.

Either the individual egg laid in the stem falls to the bottom of the internode, which is hollow, or the larva, upon hatching, crawls to the base of the internode. The larva feeds for 30 to 40 days on the inside of a single internode, generally feeding toward the top. It does not feed through a node into the adjoining internodes. When mature, the larva cuts an exit hole in the upper part of the internode and drops to the ground, burrowing from one to five inches into the soil. The abandoned internode is packed with frass and may be partly severed at its base.

The larva pupates 25 to 30 days after entering the soil. Whether it feeds on the redtop roots during this period is not known. The pupal stage lasts 10 to 14 days, after which the weevil spends some additional time as an inactive, teneral adult. The complete activities of the adult from emergence from the pupal case to winter hibernation are not known, but it appears that it spends a considerable amount of time in the soil, emerges for a short period during late September or October for relocation, and enters overwintering quarters.

Control: A limited study on the control of the redtop weevil was conducted in 1956. Very small replicated plots were treated with several insecticides, but no control, or reduction in number of infested stems, was obtained. These data indicated two things: (1) The weevils are rather mobile and cannot be successfully kept out of small treated plots, and (2) the treatments applied on June 10, 1956, were made too late. Thus, in 1957, insecticides were applied on a field basis, or to a large area, and treatment was made as soon as possible after the beginning of egg deposition. On May 16, 1957, one female of 20 collected at Flora was found to contain eggs that appeared fully developed. Treatment with insecticides was begun on May 22, and nearly all treatments were applied between May 22 and May 30. All insecticides were applied with a tractor-mounted sprayer applying 15 gallons of finished spray per acre. Data obtained from the tests conducted in 1957 are presented in Table 1.

Table 1.--Effectiveness of Dieldrin, Heptachlor, and Methoxychlor Applied in a Commercial Manner to Fields of Redtop for Control of the Redtop Weevil, Centrinaspis capillatus

Insecticide	Dosage (lb./A.)	May 22 No.	Number of weevils per sweep and percent reduction of weevils: May 31 No.	May 31 % Red.	June 6 No.	June 6 % Red.	June 13 No.	June 13 % Red.	June 19 No.	June 19 % Red.	No. of infested stems per 100 stems and % red. of inf. stems on July 7: No.	% Red.	Lb. seed/ acre
Test 1													
Dieldrin	.25		1.1	79.3	1.6	72.9	0.7	78.2	0.3	82.4	12	84.5	225
Heptachlor	.50		0.8	85.0	0.7	88.2	0.4	87.5	0.5	70.6	3	96.1	
Methoxychlor	2.00		2.2	58.5	3.2	45.8	2.4	25.0	1.7	----	72	6.5	
No treatment		1.3	5.3	----	5.9	----	3.2	----	1.7	----	77	----	78
Test 2													
Dieldrin	.25		---		11		12		2		14	82.5	
No treatment			---		58		28		23		80	----	

Note: The data for Test 1 are based on average counts made in two fields treated with each material. All plots, however, were adjacent to each other, being separated only by a fencerow, railroad right-of-way, or country lane. At least one comparison of each material involved treatment within the same field. Fields in Test 1 were treated May 22-24.

The data in Test 2 are an average of four large areas treated with dieldrin and the adjacent untreated areas. Fields in Test 2 were treated May 28-30.

The figures in Table 1 do not dramatically express the visible differences between the treated and untreated redtop. Although these data indicate that only 80 percent of the stems in untreated fields were infested, such an infestation is sufficient to make it unprofitable to harvest the remaining 20 percent. Counts made on May 22, just prior to treatment, indicate that a population of slightly more than one adult weevil per sweep was sufficient to cause a considerable amount of damage by July 7.

For good control, it appears that a protective treatment of insecticide must be made before concentrated egg deposition begins. On the basis of life history and insecticide studies conducted during 1956 and 1957, this protective treatment should be made during the last 10 to 14 days in May. In 1956, timing of treatment was based on peak population in the field on June 7, and the treatments showed no control. In 1957, timing of treatments was based on mating of adults in the field and development of eggs within the female. Good control was obtained in 1957.

One treatment of either $\frac{1}{4}$ pound of dieldrin or $\frac{1}{2}$ pound of heptachlor per acre proved to be sufficient to protect a field adequately during the period of active egg-laying by the weevils.

NEW CONTROL MEASURES FOR JOHNSON GRASS

F. W. Slife
Department of Agronomy, University of Illinois

Johnson grass is not a new problem in the United States. It was introduced into the cotton-belt area as early as 1830 as a forage crop. It is still one of our best forage crops today, but unfortunately it has moved steadily northward and now infests many of our rich bottomland soils in the southern half of the Corn Belt. It can generally be found in river bottoms in the southern one-third of Illinois, but rather sizable infestations have also been found as far north as Champaign. It is difficult to guess how far north it will migrate.

Johnson grass spreads both by seed and by underground roots. It competes so strongly with crops that 10- to 15-bushel corn yields are not uncommon in heavy infestations. In the past only cultural control has been effective--that is, either by fallowing the land for a complete year and then growing a cultivated crop until the grass gets so serious again that the fallowing must be repeated, or using small grains and fallowing the ground after the winter grain harvest. The latter method is preferable because it permits some income from the land. But because of the limitations on small-grain acreage, it is not successful enough to cope with our Johnson grass problem.

Many chemicals have been used in the past,but they have been primarily soil sterilants. In addition to being too expensive--frequently more than $100 an acre--they usually made the land useless for more than a year. Several years ago Dowpon, a chemical that is specific for eliminating grasses, was introduced on the market. Dowpon is a very temporary soil sterilant; it will last only two to four weeks, depending largely upon rainfall and soil temperature. It is not selective enough to be used in corn and soybean fields to eliminate Johnson grass, but it can be used early in the spring before these crops are planted. A rate of 10 pounds of Dowpon early in the spring, when the grass is about one foot tall, has eliminated about 80 percent of the old grass, and sometimes more. One week after treatment, the area is plowed and two to three weeks later corn or soybeans can be planted. Although this does not eliminate the Johnson grass problem, it eliminates a large part of the old grass and allows corn and soybeans to make nearly normal yields. Eight pounds of Dowpon after winter grain harvest has thus far in our test completely eliminated old grass. In this treatment the stubble is chopped immediately after wheat harvest. As soon as the Johnson grass reaches 12 to 18 inches, it is sprayed with eight pounds of Dowpon. About two weeks later, the ground is plowed.

These two treatments have given much relief from the old grass problem. But unless the seedling growth is stopped, the fields are soon reinfested with old grass. The most promising material thus far developed for controlling grass seedlings in corn is EPTC. In several tests rates as low as four pounds an acre incorporated into the soil have completely controlled Johnson grass seedlings. In addition to the EPTC, Dowpon used at rates as low as five pounds an acre in corn 60 inches tall has eliminated late-germinating seedlings. When used in tall corn, it has not damaged corn yields. Although the seedling control program is not developed far enough to make broad recommendations, the use of Dowpon before corn and soybean planting or after small-grain harvest appears to be very effective in seriously infested areas.

SYSTEMIC INSECTICIDE DEVELOPMENTS

J. H. Bigger

Until this conference you have heard very little from Illinois entomologists about systemic insecticides. Because of the danger of residues we have soft-pedaled these materials, and because we have used them only in a limited way we have very little information on them.

We now have preliminary and limited information concerning treatments on two crops which we offer for your consideration.

1. Alfalfa. During the past season Dr. Luckmann used Thimet in a limited way on alfalfa and grasses. The material was distributed as sprays and in granular form at rates of 1/2 to 1 pound of actual Thimet per acre. Results on sprayed plots were not good, but where granules were used there was good control of leafhoppers and aphids.

During early fall, seedings of the Ranger variety that had been treated with 2 pounds of Thimet per 100 pounds of seed were made alongside untreated seed of the same variety. There appeared to be no or very little effect on germination. Plants from treated seed made more rapid and vigorous growth than those from untreated seed. There were differences in the numbers of webworms and pea aphids in favor of the treated-seed area. However, the plant vigor response seemed more than could be accounted for by insect control, and on November 15 there was practically no difference in numbers of plants per square foot between treated and untreated areas.

This is a report of preliminary work which will be enlarged and more intensively studied during 1958.

2. Wheat. At the time when adults of the Hessian fly were ovipositing in April, 1957, I sprayed wheat with Systox at the rate of 3/8 pound per acre. No control of Hessian fly was obtained.

Apparently neither Thimet nor Systox was absorbed by the leaves of alfalfa or wheat respectively.

In September I planted wheat of the Knox variety treated with 1/2 pound and 3/4 pound of Thimet per 100 pounds of seed. I also used granules of Thimet distributed through the fertilizer side of a wheat drill at rates of 1 pound and 2 pounds of actual Thimet per acre. Seed treatment was definitely phytotoxic, showing 70 percent and 85 percent reduction in plant populations with the 1- and 2-pound dosages respectively. The 2-pound-per-acre granular treatment reduced plant population about 25 percent, but the 1-pound granular treatment did not significantly reduce the number of plants.

None of these treatments reduced infestations by the prune aphid, *Rhopalosiphum prunifoliae*.

Under light to moderate infestation by Hessian fly there was little or no gain in plant development, but under heavy fly infestation plants on the granule-treated plots weighed approximately twice as much as those on the untreated plot at 6-7 weeks after planting.

We obtained approximately 90 percent control of Hessian fly with both the seed treatment of 1/2 pound per 100 pounds and the granule distribution of 1 pound per acre. With both of the heavier dosages, we secured 98 percent control of the Hessian fly.

WHY HERBICIDE TREATMENTS FAIL

Earl C. Spurrier

Reasons for herbicide failures are many; some are specific, others are the result of interactions of many factors. It must be understood that an interaction of just a few factors may account for failure. Also, it is possible that internal physiological relationships, yet unknown, within the plant or weed may directly affect a herbicide reaction by either increasing or decreasing the phytotoxicity of the chemical applied and thus changing the acute relationship between the plant and chemical. The following discussion deals with factors that appear to definitely alter the degree of control obtained with a herbicide treatment.

Weather conditions (temperature and rainfall), if adverse at the time of application, can completely destroy the effectiveness of a herbicide treatment. Heavy rainfall following an application of a very water-soluble pre-emergence chemical applied to an already water-saturated soil can so completely dilute and disperse it that little, if any, remains to do the job. It can be almost completely removed in the drainage water. Also, heavy rainfall can cause the material to leach down into the soil until the heaviest concentration will be well below the active germinating zone of many shallow-rooted weed seedlings and thus never become available in strong enough concentration to permanently destroy the weed seedling. Conversely, this downward leaching of more toxic materials can place them directly in contact with a germinating crop seedling, causing the crop plant to be stunted or the stand reduced. Rainfall occurring soon after a post-emergence treatment with amino triazole or 2,4-D (amine) can definitely affect the degree of penetration and absorption into the treated plants.

It has been observed that, for maximum penetration and effectiveness, amine 2,4-D requires contact with the plant area for at least 8 hours; full effects from ester formulations of 2,4-D are apparent from 20 minutes to 2 hours after plant contact. Thus heavy rainfall immediately following an amine 2,4-D application would be critical. Rainfall would affect an application of amino triazole in a somewhat similar fashion.

On the other hand, too little rainfall following treatment with a pre-emergence herbicide, such as CDAA (Randox) or Simazin, may have equally serious consequences. Both materials depend on rainfall or high soil moisture for maximum movement in the soil, and thus too little rainfall can produce poor results. Dalapon appears to be equally as phytotoxic through root absorption as through foliage absorption. Recent field treatments of Dalapon on quackgrass in Wisconsin, followed by a period with little or no rainfall, proved to be almost completely ineffective. However, in carefully controlled greenhouse experiments with quackgrass, where water solutions of Dalapon were applied to the soil surface of pots and watered in, allowing no chemical contact with the quackgrass foliage, effective kills were obtained. This indicated that root absorption of Dalapon through soil contact might be more important than had previously been realized in making Dalapon treatments effective on quackgrass. In this case, again, rainfall following treatment is of utmost importance.

High soil and air temperatures at application time increase the rate of chemical and biochemical decomposition of herbicides that are not already within the plant. High temperatures speed up the inherent physiological reactions in the plant that are directly or indirectly associated with the phytotoxic activity of an absorbed herbicide. Subsequently the warmer the temperature at time of application or soon after, the more direct and complete will be the mode of action of the herbicide, provided entry into the plant is uninhibited. On the other hand, cool weather can reduce the rapidity of herbicidal action and increase the residual activity of certain compounds that in turn can be toxic to crop plants growing in a treated area. Climatic conditions can perhaps be one of the most important factors in herbicidal failures.

Plant maturity at treatment time can greatly influence the degree of herbicidal control. Annual grasses and broadleaf weeds are generally most susceptible to herbicidal reactions at a relatively immature stage, while they are growing rapidly. It is at this time that maximum translocation of plant substances occurs throughout the plant and that lethal concentrations of herbicidal constituents would be transferred to the plant zones, where chemical disruption is critical.

Perennial plants, on the other hand, are generally affected most at a later stage of maturity, at early bloom or just before blooming. At this time a considerable portion of root reserve energy has been expended, and root reserves are now in the process of being replenished. Herbicides applied at this time will move down into the perennial root stocks along with plant food transfer and initiate additional herbicidal action in the food storage organs.

Faulty application is often responsible for herbicide failures. Wind drift of spray materials, insufficient coverage through use of inappropriate nozzles, poorly maintained equipment, too high pressures, and misunderstanding of directions or just carelessness of the equipment operator too often turn what could have been an effective treatment into a failure, further complicated with additional crop damage. Timing of application is also important.

Personal or human factors contribute to faulty applications. Method of application, timeliness, and expected results of chemicals must be thoroughly understood. Guesswork has no place when potentially toxic materials are being used. Applying too much or too little of the chemical may cause excessive crop damage or fail to control weeds. Fatigue and inexperience of the operator also contribute to unsatisfactory results.

Penetration of the herbicide into the plant often is extremely important. However, this factor is influenced greatly by plant structure, weather conditions, chemical formulations, and application methods. For maximum effect lethal concentrations of a herbicide must be absorbed and built up in zones of physiologic activity.

Formulation breakdown is not often encountered, but it can vary the degrees of herbicidal activity. Inferior emulsifiers can cause chemical separation during storage. Freezing of certain formulations can intensify rate of breakdown and thus rapidly destroy the homogeneity of a product. Alcohol-base formulations are less susceptible to damage by freezing than others, but it is advisable to store all liquid herbicide formulations at above-freezing temperatures.

Seedbeds, if rough and poorly prepared at time of application of a preemergence herbicide, can very greatly alter the degree of weed control. Such herbicides work best on a finely prepared soil or on a soil with good tilth and texture that pulverizes quickly with minimum weathering and rainfall. Too often weeds germinate and emerge from under soil clods--areas that have not been exposed to the chemical. The areas to be treated should receive extra consideration.

There are many other factors, including plant species, soil type, sunlight, pH conditions within the plant, and others, that can directly or indirectly affect herbicidal activity. The field of weed control and herbicide application is complicated. A better understanding of these complexities is needed if herbicide applications are to be utilized to maximum advantage.

THE STRUCTURE OF INSECTS AND ITS RELATION TO CONTROL

G. E. Lehker

An understanding of the structure of insects is essential to understand control and also to identify the common household pests.

A. Characteristics of a typical adult insect

1. Three body regions

   a. The head, which has one pair of antennae, one pair of compound eyes, simple eyes and mouth-parts.

   b. The thorax, which has three pairs of legs and usually two pairs of wings.

   c. The abdomen, which has spiracles, an ovipositor in females, and miscellaneous structures, such as caudal filament and cerci.

2. External skelton

   a. Segmented body and appendages.

   b. Skeleton composed of chitin $(C_{32}H_{54}N_4O_2)X$.

   c. Skeleton composed of sclerites, which are divided by sutures and membranes.

B. Characteristics of some related groups which also have segmented bodies and appendages

1. Arachnida (spiders, ticks, and mites)

   a. Differ from insects by having two body regions, four pairs of legs, book lungs, and no wings, antennae, true jaws, or compound eyes.

   b. Resemble insects by having simple eyes and tracheae.

2. Chilopoda (centipedes)

   a. Differ from insects by having two body regions, one pair of legs on each segment, and no wings.

   b. Resemble insects by having one pair of antennae and tracheae.

3. Diplopoda (millipedes)

   a. Differ from insects by having two body regions, two pairs of legs on each segment, and no wings.

b. Resemble insects by having one pair of antennae and tracheae.

4. Crustacea (sowbugs, crayfish, lobsters, etc.)

a. Differ from insects by having two body regions, five pairs of legs, joined appendages on abdomen, two pair of antennae, no wings, and no tracheae.

b. Resemble insects by having one pair of compound eyes.

C. Insect metamorphosis

1. None--egg, young, adult

2. Gradual--egg, nymph, adult

3. Incomplete--egg, naiad, adult

4. Complete--egg, larva, pupa, adult

D. Insect mouth parts

1. Chewing

a. Chewing-lapping.

2. Sucking

a. Rasping-sucking.

b. Sponging.

c. Siphoning.

d. Piercing.

3. Degenerate types

E. Internal anatomy

1. Digestive system

a. Fore-intestine.

b. Mid-intestine.

c. Hind-intestine.

2. Respiratory system

a. Spiracles.

b. Tracheae.

c. Tracheoles.

d. Air sacs.

e. Gills.

3. Circulatory system

a. Blood.

b. Dorsal vessel.

c. Diaphragms.

4. Nervous system

a. Central system.

(1) Supra-oesophageal ganglion

(2) Sub-oesophageal ganglion

(3) Ventral nerve cord

(4) Ganglia

b. Sympathetic system.

c. Peripheral system.

5. Excretory system

a. Malphigian tubes.

b. Pericardial cells.

6. Reproductive system

a. Ovaries and testes.

b. Oviducts and vasa deferentia.

c. Associated glands.

7. Muscular system

USES FOR SOIL STERILANTS IN ILLINOIS

Earl C. Spurrier

Soil sterilizing compounds are those non-selective chemical compounds that kill all vegetation and make the treated areas incapable of supporting plant life for an indeterminant period. Soil sterilants work mainly through the soil. They must be applied at high enough rates to kill the roots as well as the newly germinating seedlings. Usually no vegetation will reappear on the treated areas for several months or possibly for as long as several years.

Salt and industrial by-products were among the first materials to be used for their soil-sterilizing properties. Later, about 1910, the arsenicals were introduced as vegetation killers, but their use as soil sterilants was limited because they were so toxic to handle. In 1926, sodium chlorate was found to be an effective and relatively cheap chemical to use for soil sterilization. It is still one of our best soil sterilants, although it creates an extreme fire hazard when used. Atlacide, a commercial compound of sodium chlorate and calcium chloride, is much less hazardous to handle and does a comparable job of controlling vegetation.

Boron and borax compounds became available shortly after the chlorates. At heavy rates of application, the boron compounds are more residual than chlorates, and this quality may be desirable where longer lasting soil residues are required. For such uses, combinations of chlorates and borates have been formulated.

Soil sterilants are classified according to the length of time the residue remains active in the soil. Temporary soil sterilants last from two to three months to as long as two years. These include such materials as TCA, Dalapon, Erbon, Atlacide, sodium chlorate, and other chlorate combinations. Semi-permanent soil sterilants usually last from two to four years and include such materials as sodium arsenite, boron compounds, Monuron, Diuron, Fenuron, and mixtures of urea and borate compounds. No sterilant is permanent because most materials will eventually leach away and thus become ineffective. Water solubility of the compound greatly determines the length of residual activity and the degree of vegetation control obtained under a particular situation. The urea compounds, introduced in 1950, are very effective against shallow-rooted perennial weeds, but are less effective against deep-rooted perennials because of their relatively low degree of solubility and hence their slower movement through the soil. More soluble materials, such as the chlorate compounds, are more effective against deep-rooted perennials because they move faster into and through the soil. In most cases, however, rainfall following application can appreciably affect the degree of control that is obtained.

No one chemical can be recommended for all uses. Dalapon and TCA are preferable for controlling perennial grasses, and they leave a residue for not more than six months. Atlacide and sodium chlorate are preferable for treating perennial weeds in cropland because they kill most of the weeds and usually disappear from the soil within one year or not more than two years. Where long residues are required, as in fencerows or around buildings and storage areas, the urea or boron compounds are best to use. Sodium arsenite is too toxic to man and animals to be generally recommended. Erbon appears to have promise as a temporary sterilant in the class with Atlacide and sodium chlorate.

In addition to the aforementioned chemicals, others are on the market that undoubtedly will have a place for soil sterilization purposes, although further evaluation is needed.

Soil sterilants have a place in Illinois. First, they are perhaps most effective for destroying patches of perennial weeds that cannot be destroyed by other means. The materials will make the land useless for crops for a time; but if they prevent the weeds from spreading, then their use is justified. For example, some of our primary noxious weeds, such as Canada thistle, perennial sow thistle, leafy spurge, and field bindweed, can be easily eradicated with heavy rates of a soil sterilant. Second, they can control vegetation around barns and other outlying buildings and thus reduce fire hazards. Also, labor demands can be cut if soil sterilants are used in fencerows to keep down vegetation.

Perhaps the biggest outlet for soil sterilants in Illinois is to control vegetation around industrial sites, including drive-in theaters, railroads, factories, and other types of public utilities. The choice of a chemical should be determined by cost, length of sterility required, and type of control needed.

Soil sterilants, when properly used, offer a very effective means of controlling vegetation. If the problem area is small, their use can be maximized because cost is then not a major consideration. Perhaps more soil sterilants should be used in Illinois for specific purposes. However, before using, read container labels to determine use and rate and extent of toxicity to both man and animals.

A PRELIMINARY REPORT ON THE SPOTTED ALFALFA APHID IN ILLINOIS IN 1957

W. H. Luckmann

Preliminary investigations on the spotted alfalfa aphid in Illinois were begun in 1957 at Carlinville, Lebanon, Brownstown, and Anna. Biological studies on response of the aphid to alfalfa growing in soils of varying fertility were conducted at Lebanon and Carlinville, and insecticide studies were conducted at Brownstown and Anna. General observations on abundance of the aphid were made in southwestern Illinois.

The spotted alfalfa aphid did not overwinter in Illinois but was first found this year in mid-June in Jackson County. Few aphids were collected during the summer, and the first significant and damaging populations were observed during the last half of August in extreme southern Illinois. A survey during this period conducted along Routes 127, 146, and 3 in Jackson, Union, and Alexander Counties indicated that very few aphids were present in the Mississippi River bottoms, but high populations were found in the upland areas of these counties. The higher populations of spotted aphids seemed to be associated with hilltops and ridges.

Aphid populations fluctuated constantly during August, September, October, and November. The highest populations of the season and the most damage were observed during August. Usually when a population had reached damaging numbers, unfavorable conditions rapidly decreased the population to non-economic numbers. The aphid seems to be greatly influenced by the weather in Illinois. A hot, dry condition appears most favorable. Droughty areas, such as hilltops and ridges, also seem to be favorable, while flood plain areas appear to be less favorable.

On August 29 three fields of alfalfa near Anna were treated with insecticides to control the spotted aphid. Of the three fields, Field 1 was already a few days past harvest at time of treatment, but it had been damaged so severely that the grower did not intend to cut what remained. Field 2 was near bloom at treatment, and Field 3 had been cut 10 days prior to the treatment applied on August 29. On the day of treatment, the mature field that had been damaged severely contained only 12 aphids per sweep; the field approaching bloom, Field 2, contained 1,166 aphids per sweep; and Field 3 contained 96 aphids per sweep. Systox (2 oz. per acre), malathion ($\frac{1}{2}$ lb. per acre), and malathion in oil (1 gal. of horticultural oil containing $\frac{1}{2}$ lb. tech. malathion per acre) were applied as sprays at the rate of 6 gallons of finished spray per acre. Thimet (1 lb. per acre) was applied in the form of 8 percent granules.

Counts of aphids were made seven days after treatment, but counts were not made 14 days after treatment because the weather or other factors or the mature condition of the crop in all the fields had so reduced the over-all population that few aphids remained in the untreated areas. Seven days after treatment the highest population was in Field 3, where the untreated portions contained 1,368 aphids per sweep. Systox reduced the population 98.3 percent, and there was an average of only 4 winged and 20 wingless aphids per sweep. Thimet reduced the population 97.2 percent, with a ratio of 6 wingless to every winged specimen. Malathion emulsion and malathion in oil reduced the aphid population from 60 to 80 percent.

The information given here, as well as control recommendations from Arizona, California, and Kansas, indicates that 1/8 to 1/4 pound systox, 1/4 pound parathion, or 3/4 to 1 pound malathion per acre will give good control of the spotted alfalfa aphid. The higher dosages are recommended for aerial applications. Treatment with insecticides must be done thoroughly and accurately, since "skips," or small untreated areas, act as sources for rapid reinfestation.

SIMAZIN, A NEW HERBICIDE

F. W. Slife
Department of Agronomy, University of Illinois

Simazin is one of the more promising new herbicides that has been discovered in recent years. It is a pre-emergence compound, which means that it is applied to the soil immediately after planting. It is an unusual compound in that, of all of our major crops, corn is the only one that seems to have a high degree of tolerance to it. No detrimental effect has been observed on corn where as much as eight pounds of active ingredient per acre has been applied. Under ordinary circumstances, two pounds per acre will adequately control weeds. Soybeans have very little tolerance to this chemical, and it would therefore appear that in the corn-belt area its main use will be to control broadleaf weeds and grass in corn.

At the end of two years of experimental work, Simazin has performed with a high degree of success in most cases. It has not, however, been evaluated enough under conditions of limited rainfall to know how it will perform. The fact that it is highly insoluble may mean that if rain does not fall for several weeks after application the weeds will be too large to be effectively controlled. It has, however, worked exceptionally well when rain has fallen within a week or ten days after application.

At two pounds per acre Simazin will give good control of weeds all season long. This makes it particularly desirable to use where it seems advantageous to cut down on the number of corn cultivations. This long a residue, however, creates other problems. In tests at Missouri, as little as two pounds has caused some injury to winter wheat planted in the fall. In Indiana, the four-pound rate applied to corn in the spring of 1956 produced some slight injury to soybeans planted on the same plots in 1957. This chemical will not be recommended until a more thorough investigation of its soil residue has been completed.

It is expected that Simazin will be rather expensive in the early stages of development, necessitating a band treatment over the corn row. It is now available as a wettable powder. That may mean that use of piston-type pumps would be preferable to regular geared pumps. However, preliminary information does not indicate that it causes excessive wear on gear pumps. Simazin has a low order of toxicity to both man and animals.

PROGRESS REPORT ON BAND SPRAYING

Wendell Bowers and Earl C. Spurrier

Farmers in Illinois are rapidly accepting the use of pre-emergence herbicides on cropland as a standard weed control practice. Band spraying appears to be a practical and readily accepted method of applying these chemicals at planting time with equipment attached to the planting equipment. Observations made in 1956 indicate that the use of inappropriate nozzles, too high pressures, and other mechanical and weather factors were responsible for many failures where pre-emergence herbicides were used. Also, some simple type of soil covering equipment was deemed advisable to overcome the problem of chemical loss due to volatilization and evaporation of certain chemicals--and thus improve their effectiveness for weed control.

Research Results

Experiments were started in 1956 and continued through 1957 to obtain information dealing with band-spraying techniques and soil-covering methods. The experimental areas were seeded with foxtail millet, *Setaria italica*, as the test grass. CDAA (Randox), a grass selective pre-emergence herbicide, was used as the test chemical. It was applied at the rate of 1 gallon in 20 gallons of water per acre in 10-inch bands across the seeded areas. Plant counts of emerging grass seedlings in the treated bands were used to compare the degree of chemical control obtained with the various spray techniques. Five experiments were conducted, the treatments were replicated four times, and most of the data subjected to statistical analysis. In one experiment EPTC was included as a test chemical.

The test results were summarized and the significant observations are listed as follows:

1. Pressures of 30 to 40 pounds per square inch (psi) were quite satisfactory for band applications of CDAA (Randox), a pre-emergence herbicide, when nozzles capable of delivering the prescribed rate of spray material were used. Pressures approaching 100 psi permitted excessive wind drift of spray from the band and thus gave a skewed spray pattern and reduced grass control in the sprayed band. A gravity distribution system controlled grass satisfactorily and appeared to merit further consideration as a means of applying spray.

2. A nozzle height about 10 inches above the soil surface gave a satisfactory spray pattern in the treated band.

3. Shields designed to protect the spray pattern from wind drift did not increase the degree of grass control even in crosswinds up to 25 mph when nozzles were 10 inches above the soil surface and when spray pressures were less than 40 psi. Observations made at time of application indicated that much drifting of spray particles occurred after soil contact. It was easier to reduce drift by reducing pressure than by using shields. Pressures of 30 psi reduce the chance of spray drift.

4. Hand covering or incorporating CDAA (Randox) in a treated band in the soil increased its effectiveness compared with an undisturbed surface application.

5. Applying the spray material in a band ahead of the planter and allowing the planter shoe and press wheels to mix the spray with the soil did not satisfactorily control grass.

6. When CDAA and EPTC were compared for grass control at both a 2-pound and a 4-pound rate, there was less difference in degree of control between the 2- and 4-pound rate with CDAA than with EPTC. Both chemicals were more effective when covered; however, grass control was much better between the covered and uncovered plots of EPTC than of CDAA. This indicates that covering or some method of soil incorporation is necessary if the full effectiveness of EPTC is desired.

7. A number of mechanical soil-covering devices were developed and compared. Placing a thin layer of soil over the treated band may make it possible to reduce the degree of chemical loss due to evaporation and volatilization of various volatile herbicides and perhaps make them more effective, particularly when they are applied during dry weather.

Recommended Practices

1. Apply a Surface Spray at Recommended Rates

   a. Use a 12-13 Inch Band. This width helps to insure more satisfactory weed control when followed with cultivations.

   b. Keep Pressures Low. Control was significantly reduced when pressures were raised to 100 psi. Further observations indicated that pressures should be kept under 40 psi to reduce the tendency to drift.

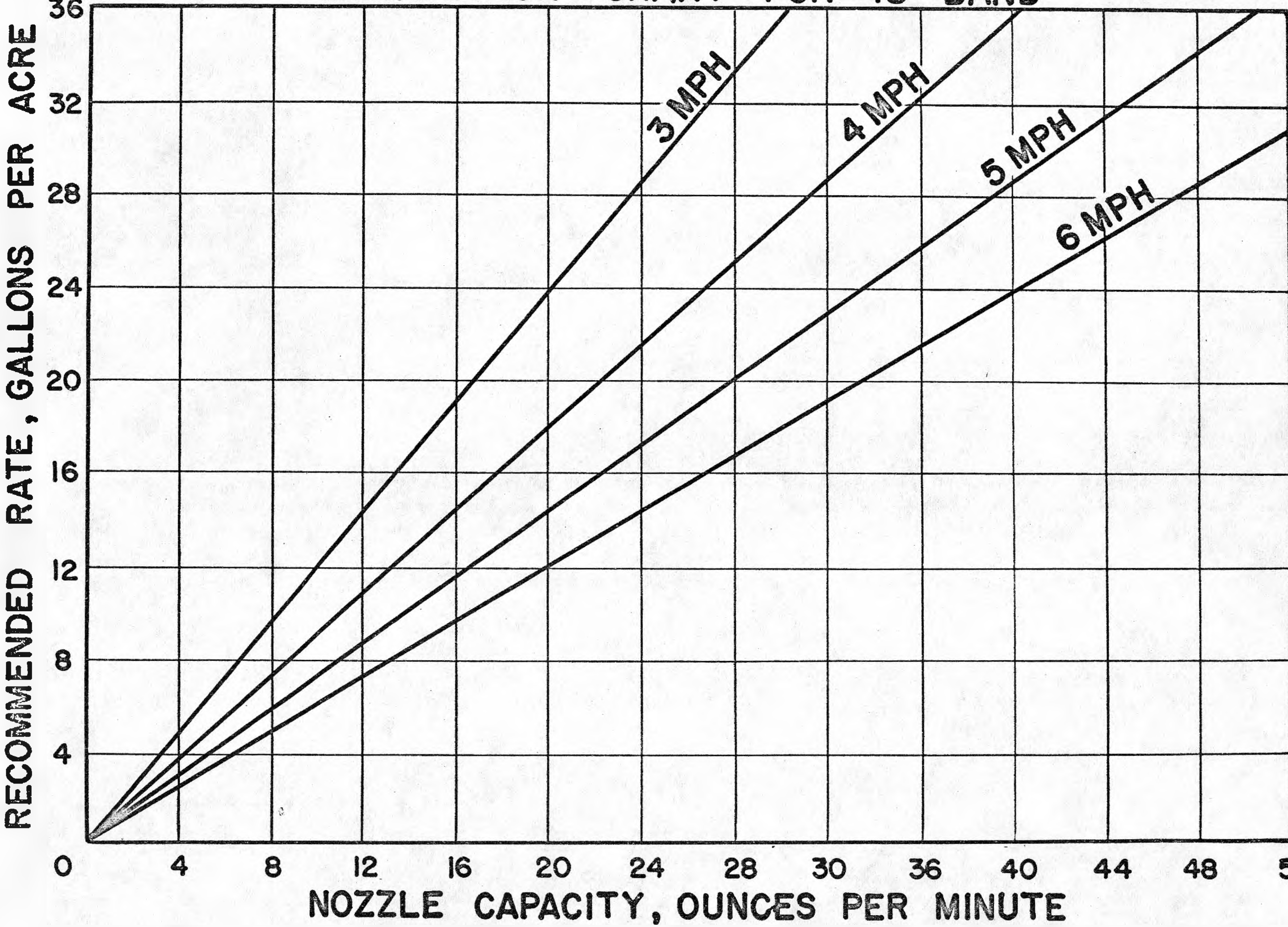
   c. Choose Nozzle Tips Carefully. Base nozzle selection on pressures under 40 psi. The chart on page 42 will help you select and calibrate the nozzle. Don't hesitate to change tips if you cannot get the correct discharge at pressures under 40 psi.

   d. Calibrate Equipment With Accuracy. Ground speeds need to be checked with a ground speed indicator in the field where you will be working. If a speed indicator is not available, determine the number of seconds it takes to drive between markers 88 feet apart. For a better check, use a running start. The following table shows the time in seconds required to cover 88 feet for various ground speeds:

Time in Seconds	Speed, Miles per Hour
30	2
20	3
15	4
12	5
10	6

Once speed has been adjusted, use the same throttle setting for nozzle calibration.

CALIBRATION CHART FOR 13" BAND



OUNCES x .0078 = GALLONS PER MINUTE

e. Trouble Shooting.

(1) Faulty or Irregular Pattern - Check for plugged or damaged nozzle. Never use a hard object to clean nozzle tips. Blow them out or use a toothpick.

(2) No Pressure - Pump not primed. Increase speed for a few seconds. Check to see if hoses are properly connected and tightened securely.

(3) Band Too Wide - Raise nozzle.

(4) Excessive Drift - Reduce pressure. Change to larger nozzles if necessary to get pressures below 40 psi.

(5) Pressure Fails to Adjust Low Enough - Pressure regulator may be stuck or insufficient material is being by-passed. Use a larger by-pass hose or add a second one.

(6) Failure to Get Proper Nozzle Discharge at Recommended Pressure - Nozzle may be plugged or screens are clogged.

CAUTION!

Some pre-emergence chemicals are irritating to the skin. Heed warnings on containers. Do not hesitate to use rubber gloves and goggles.

WHAT INSECTICIDE RESIDUES ARE AND WHAT THEY MEAN

G. C. Decker

Broadly speaking, any substances appearing or remaining on or in plant or animal products or on any surface or inanimate object as a result of insecticide usage may be regarded as insecticide residues. In this discussion, however, we will be concerned only with insecticide residues on or in crops and other agricultural products.

The amended Food, Drug, and Cosmetic Act provides that any or all pesticides appearing on or in raw agricultural commodities are to be considered contaminants and are therefore unlawful unless the chemical in question has been exempted from the requirements of a tolerance or unless the amount present is less than a legally established tolerance. This means that all proposed insecticide usages must take into account possible or probable residue hazards.

In case a food product is found to be contaminated and in violation of the law, some legal action is possible--if not, indeed, probable. Everyone, from the manufacturer of the chemical to the possessor of the product when legal procedures are instigated, and all intermediaries, will be under suspicion, and each one will be trying to pin the blame on someone else. That could be you, or you, or you, and perhaps even I. Therefore, it is imperative that each and every one of us see to it that our activities are above reproach, or even suspicion.

The magnitude of initial spray deposits and the rate at which such deposits are lost may be determined by the combined action of many independent factors. Thus we should all strive to continually improve our working knowledge of the important factors that determine the magnitude of insecticide deposits and their rate of loss.

We discussed some of these factors at our last two meetings, and from time to time you may find it profitable to review or, better still, study critically the material presented in your 1956 and 1957 manuals.

Practically all surveys of residues at harvest time tend to show that, when our modern insecticides are used in accordance with approved label instructions, harvest residues are well within established tolerances. Our old friend, lead arsenate, seems to have a greater tendency to exceed the tolerance than any of the commonly used synthetic organic compounds.

The long-standing policy of no tolerance for insecticides in milk still prevails. This in a sense means that tolerances for insecticides on forage crops will be established only when it is clear that the feeding of forage so contaminated would not cause milk to be contaminated.

Since milk represents a critical area, we should give special consideration to this problem:

1. Milk can be contaminated by insecticides absorbed through the skin as well as those obtained by ingestion. Therefore, we must guard against improper use of unapproved materials, such as fly sprays, animal dips, etc.

2. It is important to keep animals, especially dairy animals, off treated pastures for specified intervals after treatment. One day of feeding in a pasture immediately after spraying may do

more damage to the milk supply for a month or six weeks than two weeks of feeding on the same pasture a week or ten days later.

3. In cases where a tolerance has been established for a specific insecticide in animal fat, feed and forage contaminated by that product that could not be legally sold or fed to dairy cows might be fed to steers or other meat animals, provided the residue level was not high enough to induce deposits in fat in excess of the official tolerance.

FORMULATIONS AND DRIFT HAZARDS OF 2,4-D

F. W. Slife

The widespread use of 2,4-D has solved many of our weed problems. It has, however, brought some undesirable effects. The greatest of these is drift of the chemical onto nearby sensitive crops. In the early years drift was not much of a problem because the only way of applying the 2,4-D was with large sprayers that delivered 100 or more gallons of solution an acre. Since the low-volume sprayer was introduced about 1946, however, the drift problem has been magnified many times.

The hazard is greatest during application. A sprayer that delivers 5 to 10 gallons of solution an acre releases many, many very fine particles. With only a slight wind, these particles can be carried many thousands of feet (there are cases where cotton has been severely damaged as far as 10 miles from point of application). The problem has become so serious that some states have passed laws to prevent the use of 2,4-D in certain areas, and others have applied other restrictions. If growers would follow good, sensible application procedures, we could prevent legislative restrictions on the use of 2,4-D.

Perhaps in Illinois 2,4-D presents the greatest hazard to commercial tomato acreage. There are perhaps half a dozen areas in Illinois that grow a rather substantial acreage of tomatoes. During the past few years, injury from 2,4-D has increased. It seems to have been due largely to the thoughtlessness of people who did not realize the seriousness of this type of injury or the tremendous financial loss that would be involved.

As custom spray applicators and chemical dealers, it is our place to point out these hazards and to do everything in our power to eliminate them. The mere fact that there is a cornfield between a tomato field and the field in which you are applying 2,4-D does not mean that this will stop the drift of 2,4-D. In all probability it will go right through the corn rows and land on the tomatoes, causing severe damage. It seems logical that 2,4-D should not be used within one-half mile of a tomato field, and it should not be used at all if the wind is blowing toward the tomatoes. In fact, it is best never to apply 2,4-D on windy days. Practically every farmstead has tomatoes in the garden, susceptible flowers, and perhaps grapevines. When we damage them, we are casting a shadow on our profession and prejudicing potential customers against the use of farm chemicals. We strongly believe that most of the damage caused by 2,4-D is caused during application when particles of the spray drift with the wind. It is also possible, however, to get damage after application. A certain form of 2,4-D goes into the air as a gas; if this gas alights on sensitive plants it will cause a great deal of damage.

Since 2,4-D acid is not soluble in water, it must be mixed with other chemicals to make it soluble. One of the first formulations used in 2,4-D manufacture was different types of salts. Sodium salt became most important for several years. Later the amine formulations, as well as the ester formulations, were used. Since sodium salt was the least effective of the three formulations, it eventually disappeared from the market and is not used today in any large quantities. Sodium salt presented a hazard during application because it would not volatilize. The amine formulation also is most hazardous during application. It volatilizes very little. The volatile ester forms, too, present a considerable hazard because they produce a gas after application. The volatile esters that are available today include methyl, ethyl, butyl, isopropyl, and amyl.

The volatile esters should not be used in areas where there are large acreages of sensitive crops. Although the wind may be blowing during application a wind several hours later could cause extensive damage. Low-volatile esters, which were introduced several years ago, are an improvement over volatile esters, as they volatilize no more than the amine formulations once they are applied. The only really hazardous formulation in terms of volatile vapors is therefore the volatile esters of 2,4-D.

The different formulations of 2,4-D appear to show little difference in distance they will drift with the wind. Since the molecules are similar in size, it would seem that they might be carried equal distances. We should remember, however, that the ester forms have the greatest effect; if an amine formulation drifted the same distance and at the same rate as the ester form, it would cause much less damage. Therefore, when a 2,4-D must be used in areas where sensitive crops are being grown, we strongly recommend using the amine formulation--first, to prevent volatility and, second, to minimize and possibly eliminate hazard of drift. This practice, along with good application procedures, should help to prevent much of the damage that is being caused by careless application of 2,4-D.

INSECT SITUATION IN ILLINOIS, 1958 AND SUMMARY OF 1957 INSECTICIDE CONTROL MEASURES

H. B. Petty and C. E. White

Each year county farm advisers estimate the acres treated to control various insects. These estimates, made independently, fit into definite patterns that usually coincide with our own estimates. Where we do not have actual yield data, we estimate the profit per acre from treatment. We subtract a bit to get a conservative figure and then apply this figure to the entire acreage. The results shown in Table 1 include only a few specific insects and not all insect pests on which control was used in 1957.

Table 1.--Use of Insecticides in Illinois

Insects	Acres treated	Estimated profit
Meadow spittlebugs	9,896	$ 19,750
Potato leafhoppers	25,262	50,520
Spotted alfalfa aphids	2,407	12,000
Sweet clover weevils	12,172	12,000
Clover leaf weevils	18,190	18,190
Soil insects	657,267	1,643,100
Chinch bugs	4,598	22,890
Cutworms	16,146	80,730
Grasshoppers	22,878	114,390
Corn borers	165,408	661,630
Fall armyworms	61,760	61,760
Total	934,224	$2,696,960

Seventy-one percent of the soil insecticide treatments involved insecticide fertilizer mixes; 23 percent, sprays; and 6 percent, granules. Forty-six hundred acres were treated to control chinch bugs, and only 201 acres of corn were lost to this pest. While 16,000 acres were being treated to control cutworms in corn, an additional 15,000 acres had to be replanted because of damage from this pest.

In our annual survey we also obtain estimates of the acreages treated by aerial applicators, commercial ground applicators, and individuals. This year the percentage of acreage treated by airplanes was down and that by commercial ground applicators was up, but the total of the two is still 47 percent of the acreage, comparing favorably with results of the past two years (Table 2).

Table 2.--Methods Used in Applying Chemicals and Extent of Use, 1957

Insect	Airplane	Commercial ground applicator	Individual
		Acres treated	
Legume insects	2,928	25,458	43,135
Chinch bugs	0	2,367	1,506
Grasshoppers	1,415	5,002	16,465
Corn borers	38,621	46,177	79,307

(Cont.)

Table 2 Cont.

Insect	Airplane	Commercial ground applicator	Individual
	Percent of total acreage treated		
1954	18.3	20.2	61.5
1955	24.8	29.0	46.2
1956	24.8	24.8	50.4
1957	16.4	30.1	53.5

Insect Abundance in 1957 and Outlook for 1958

The outlook for European corn borer in 1958 is far more favorable than it has been for the past few years. Table 3 shows the average annual fall corn borer populations since 1950, and Map 1, the populations for the fall of 1957. The populations have been decreasing noticeably for two years. The wintering populations of this year were highest in an area north of a line from St. Louis to Cook County and south of a line from Rock Island to Cook County. In this area the largest populations were centered in the southwest section. The high incidence of diseased borers was the most heartening thing about this year's population. By late fall higher percentages of borers were dying than have died in the past. Dr. Briggs discussed diseases affecting the corn borer at the Ninth Custom Spray Operators' Training School. Parasitism by the imported fly Lydella grisescens also has been high. We do not anticipate a great need for corn borer insecticide treatments to control the first-generation borer this coming season. However, if conditions should be favorable, the second generation could develop into a serious problem. We will know more by August 1, 1958.

In our first-generation borer surveys (Table 4), the population was 61 borers per 100 stalks of corn in 1955, 100 borers per 100 stalks in 1956, and only 7 borers per 100 stalks in 1957. The second-generation population in the same counties decreased from 523 to 185 to 127. It must be noted, however, the the increase in ratio of first-generation borer to second-generation numbers was 18 in 1957, 2 in 1956, and 9 in 1955.

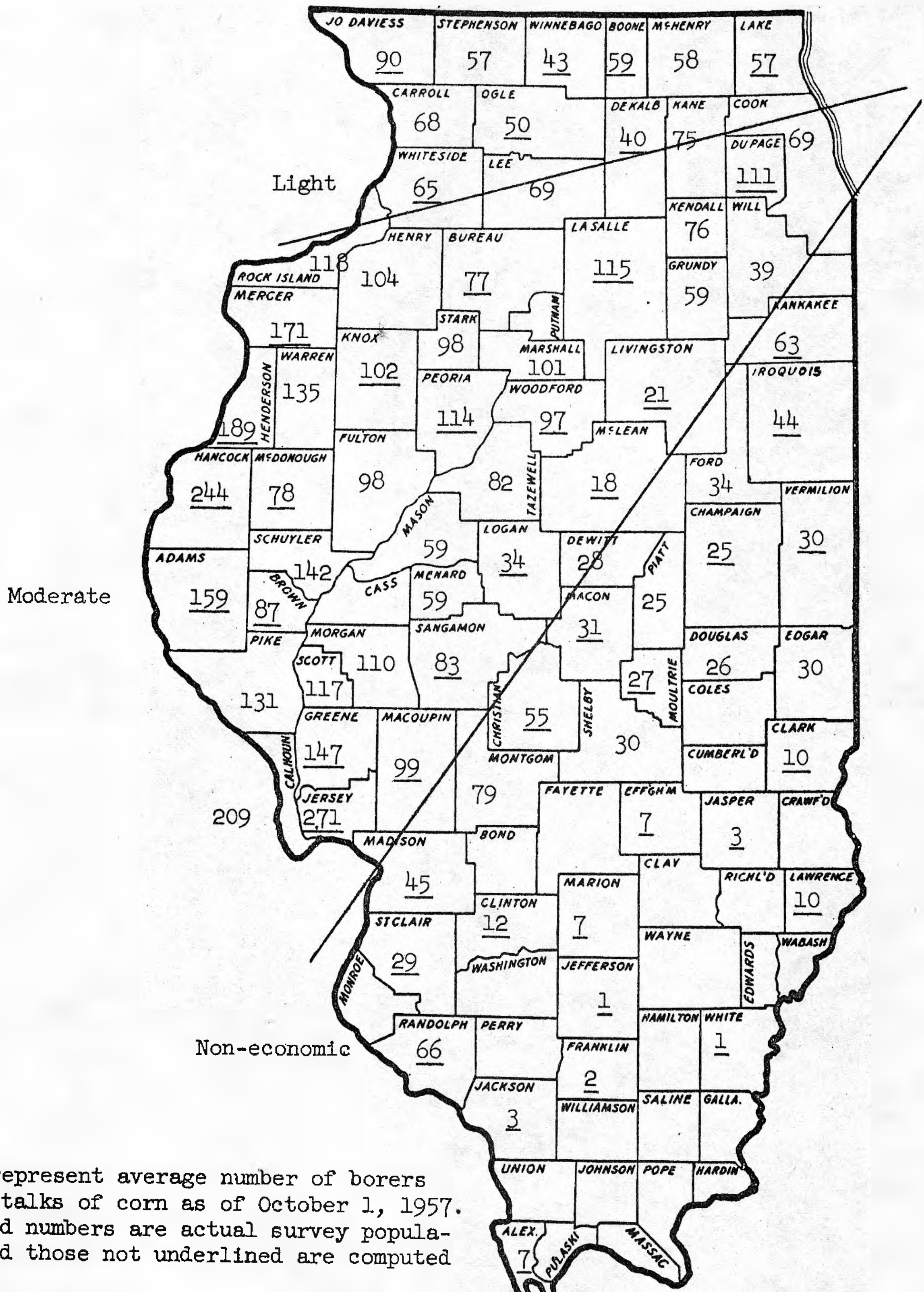
The insect attracting most attention on corn in 1957 was the fall armyworm. We cannot predict its abundance for 1958, since it does not winter in Illinois but migrates in from the south. Fall armyworm damage at first appears similar to the tassel and whorl damage caused by the corn earworm, but there is a distinct difference: Fall armyworm moths lay their eggs on the leaves in masses of 100 to 150. The small worms migrate to nearby plants. Thus an infested spot involves several hills and several rows. The corn earworm lays her eggs one at a time, and damage is usually confined to one plant in one place.

Fall armyworms feed in the whorl, severely chewing the developing leaves but seldom killing the heart of the plant. The worms usually mature shortly before they reach the heart of the plant; they then leave the plant and pupate. Under favorable conditions the plant will probably grow out of the feeding damage. The emerging upper leaves show no signs of damage, and only the lower leaves have been affected. We do not yet know whether this retards plant growth enough to affect yields. In a few instances in 1957 very late corn was almost destroyed. Most fields, however, apparently outgrew the damage. The armyworm causes the most severe damage to the

Table 3.--Corn Borer Population Surveys in 36 Counties, 1950-1957
(County Averages Expressed in Borers per One Hundred Stalks of Corn)

	1950	1951	1952	1953	1954	1955	1956	1957
Northwest								
Jo Daviess	125	61	104	64	140	609	110	90
Winnebago	87	33	70	102	171	414	201	43
Ogle	98	55	157	153	422	852	148	50
Whiteside	80	65	99	177	340	401	292	65
Bureau	46	15	172	168	325	270	90	77
Mercer	8	63	63	582	763	382	408	171
Average	74	49	111	208	360	488	208	83
Northeast								
Boone	76	7	57	59	98	334	106	59
Lake	132	6	31	45	103	243	127	57
DeKalb	49	4	52	144	324	541	186	40
DuPage	30	13	6	117	134	395	104	111
Will	27	33	104	293	445	435	97	39
LaSalle	80	21	124	371	289	532	225	115
Average	66	12	62	172	232	413	141	70
East								
Kankakee	36	43	90	512	519	600	86	63
Iroquois	73	44	80	573	511	839	88	44
Livingston	54	20	123	405	677	887	127	21
Vermilion	51	3	23	125	323	840	135	30
Champaign	76	11	11	24	104	622	283	25
Average	58	24	65	328	427	758	144	37
Central								
Peoria	38	56	120	350	515	300	198	114
Woodford	22	55	128	504	524	343	169	97
McLean	37	37	41	180	490	628	161	18
Logan	46	35	6	51	140	291	211	34
Macon	19	18	6	8	94	359	404	31
Average	32	40	60	219	353	384	228	59
West								
Henderson	27	53	47	339	382	424	305	189
Knox	37	34	71	266	240	434	353	102
Hancock	24	36	9	59	224	215	94	244
McDonough	75	68	33	128	330	323	183	78
Adams	110	46	29	128	79	107	58	159
Brown-Cass	51	82	9	50	131	248	110	87
Average	54	53	33	162	231	292	184	143
West-Southwest								
Sangamon	34	8	7	17	38	238	208	83
Christian	49	59	18	9	17	117	227	55
Madison	46	54	26	24	4	53	50	45
Average	43	40	17	17	20	136	162	61
Southwest								
St. Clair	46	34	19	29	21	14	74	45
Average	46	34	19	29	21	14	74	45
East-Southeast								
Moultrie	58		4	20	23	225	122	27
Clark	47	4	3	21	20	47	16	10
Jasper	63	15	28	17	1	16	52	3
Lawrence	32	23	29	21		36	2	10
Average	50	11	16	20	15	81	48	13
AVERAGE, ABOVE 36 COUNTIES	55	32	56	170	256	378	161	70
AVERAGE, ALL COUNTIES SURVEYED	51	34	47	126	182	282	143	66

Map. 1--1958 Corn Borer Prospects



Figures represent average number of borers per 100 stalks of corn as of October 1, 1957. Underlined numbers are actual survey populations, and those not underlined are computed figures.

Table 4.--First- and Second-Generation Corn Borer Populations

	Oct. 1954	July 1955	Oct. 1955	July 1956	Oct. 1956	July 1957	Oct. 1957
	Borers per 100 Stalks of Corn						
Northwest							
JoDaviess	140	38	609	183	110	--	--
Winnebago	171	--	414	136	201	7.4	43
Ogle	422	62	852	274	148	6.8	50
Whiteside	340	26	400	85	292	7.0	65
Bureau	325	57	270	66	90	8.0	77
Mercer	763	119	382	74	408	21.0	171
Average	360	60	503	136	208	10.0	81
Northeast							
Boone	98	32	334	73	106	0.12	59
DeKalb	324	85	541	158	186	1.6	40
Will	445	--	435	86	97	1.2	39
LaSalle	289	--	532	134	225	2.4	115
Average	289	59	438	113	153	1.3	63
East							
Kankakee	519	66	600	101	86	1.2	63
Iroquois	511	30	839	62	88	1.2	44
Livingston	677	283	887	42	127	--	--
Champaign	104	4	622	15	283	2.8	25
Average	453	96	737	55	171	1.7	44
Central							
Peoria	515	43	300	--	198	--	--
Woodford	524	31	343	--	169	--	--
McLean	490	38	628	64	161	0	18
Logan	--	--	--	--	--	8.0	34
Average	510	37	424	64	161	4.0	26
West							
Knox	240	40	434	38	353	17.0	102
McDonough	330	20	323	--	183	5.0	78
Average	285	30	379	38	268	11.0	90
West Southwest							
Christian	--	--	--	--	--	8.0	55
Sangamon	--	--	--	--	--	25.0	83
Macoupin	--	--	--	--	--	30.0	99
Jersey	--	--	--	--	--	90.0	271
Average	--	--	--	--	--	38.0	127

Average Populations in a 16-County Comparison

	1st generation	2nd generation
1955	61	523
1956	100	185
1957	7	127

ear of corn. The small worms migrate across the leaves and into the ear, where the damage resembles that of the corn earworm. The earworm moth deposits her eggs in the silks, and the young larvae merely follow the silk channel into the ear. Because of this difference, the damage caused by the fall armyworm is easier to prevent than that caused by the earworm.

If fall armyworms are found on 20 percent of the plants in the field, control measures may be warranted, but treatment must be applied when the worms are small to get full value. If the worms are large and ready to pupate, chemicals will be largely wasted.

Corn earworm did not develop to the extent that we assumed it might. First earworm eggs were found on field corn in Urbana in mid- to late June. However, even by fall the damage was not so great as in some years past even though some fields in the south were heavily infested. A disease killed corn earworm and also fall armyworm during late summer and fall. Earworm moths migrate to Illinois in the spring, and therefore no predictions can now be made for 1958.

The moth of the black cutworm also migrates into Illinois in the spring. We had less damage this year than in the previous two or three years. Control measures for black cutworms should be applied when the first damage is observed. If three or four days are allowed to intervene, damage can be severe, as these worms are voracious and work rapidly.

Grasshoppers were not too important in 1957, and only limited control measures were necessary. Our adult grasshopper survey shows that an area in northwestern and western Illinois may have a slight potential for next year (Map 2). If June is dry, we may expect some localized outbreaks in the most heavily infested areas.

Chemicals were used to control chinch bugs in eastern Illinois in 1957. Barley and wheat were treated to control these insects, particularly the adults that were damaging the grain. Our potential problem lies in an area in central Illinois (Map 3).

Armyworm moth flight was moderately heavy in 1957, but infestations were diluted over a large area. The moths deposit eggs in grains and grasses of luxuriant growth. Apparently they found many suitable places for oviposition, and there were no concentrations that warranted control. Because armyworm moths fly into Illinois from the south, we can make no predictions for 1958.

The corn flea beetle, which disseminates Stewart's disease or bacterial wilt of corn, was not extremely abundant this year. Counts do not indicate that these beetles were heavier than normal this past fall, but if we have a mild winter we may have more of them this coming season.

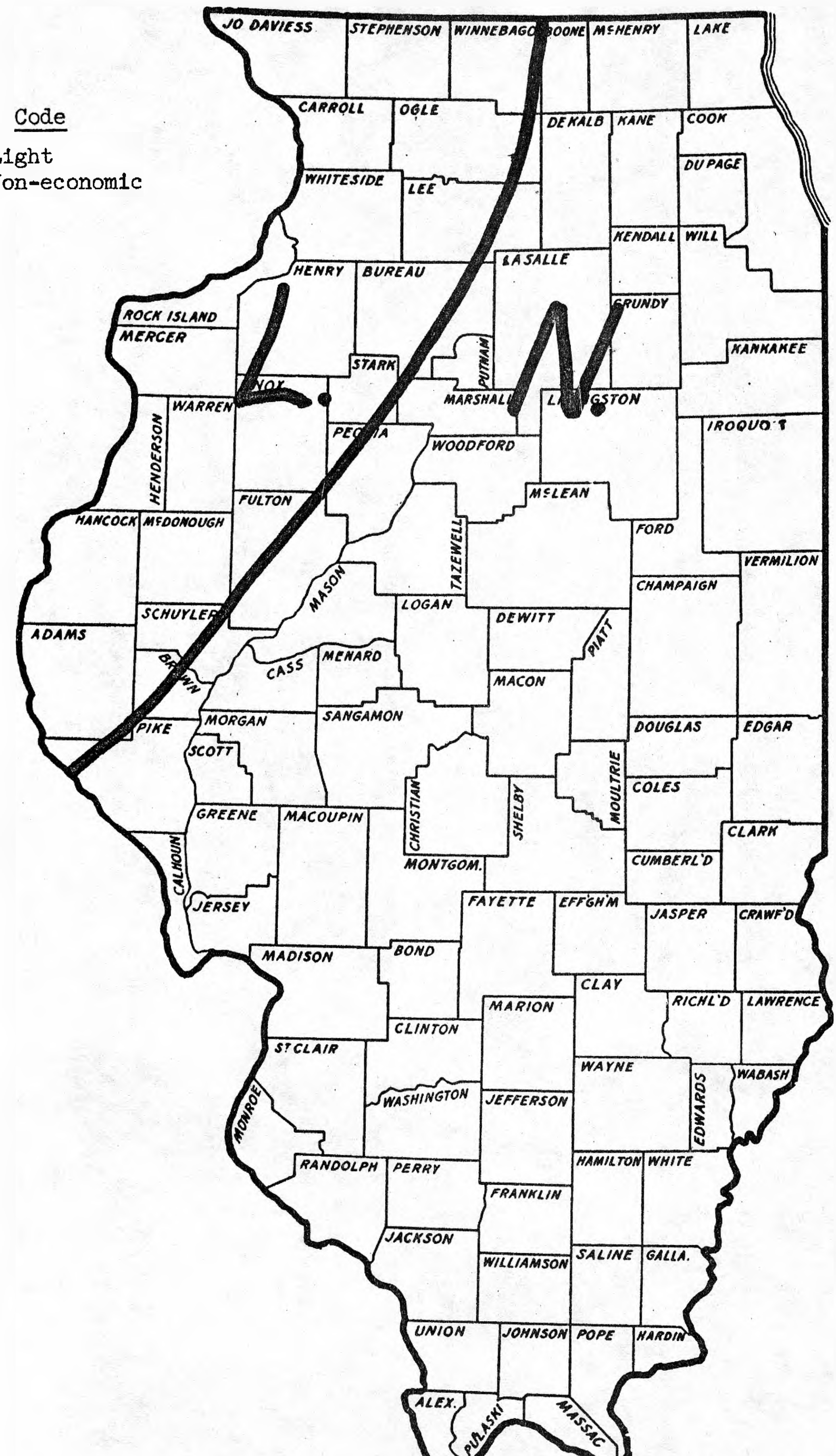
In the spring of 1957, clover leaf weevil was fairly abundant in some fields. These fields were definitely being stunted. Temperatures and moisture became high enough, however, to cause the fungus disease to kill many of the weevils. Thus the potential for next year has been reduced. Some weevils will be present in 1958, and if plant growing conditions are not good and the weather is favorable for the weevil, we can have trouble from this pest.

Spittlebugs were rather abundant in the northern third of Illinois, and first cuttings of hay in some fields were damaged. The fall spittlebug survey

Map 2.--Grasshopper Potential, 1958

Code

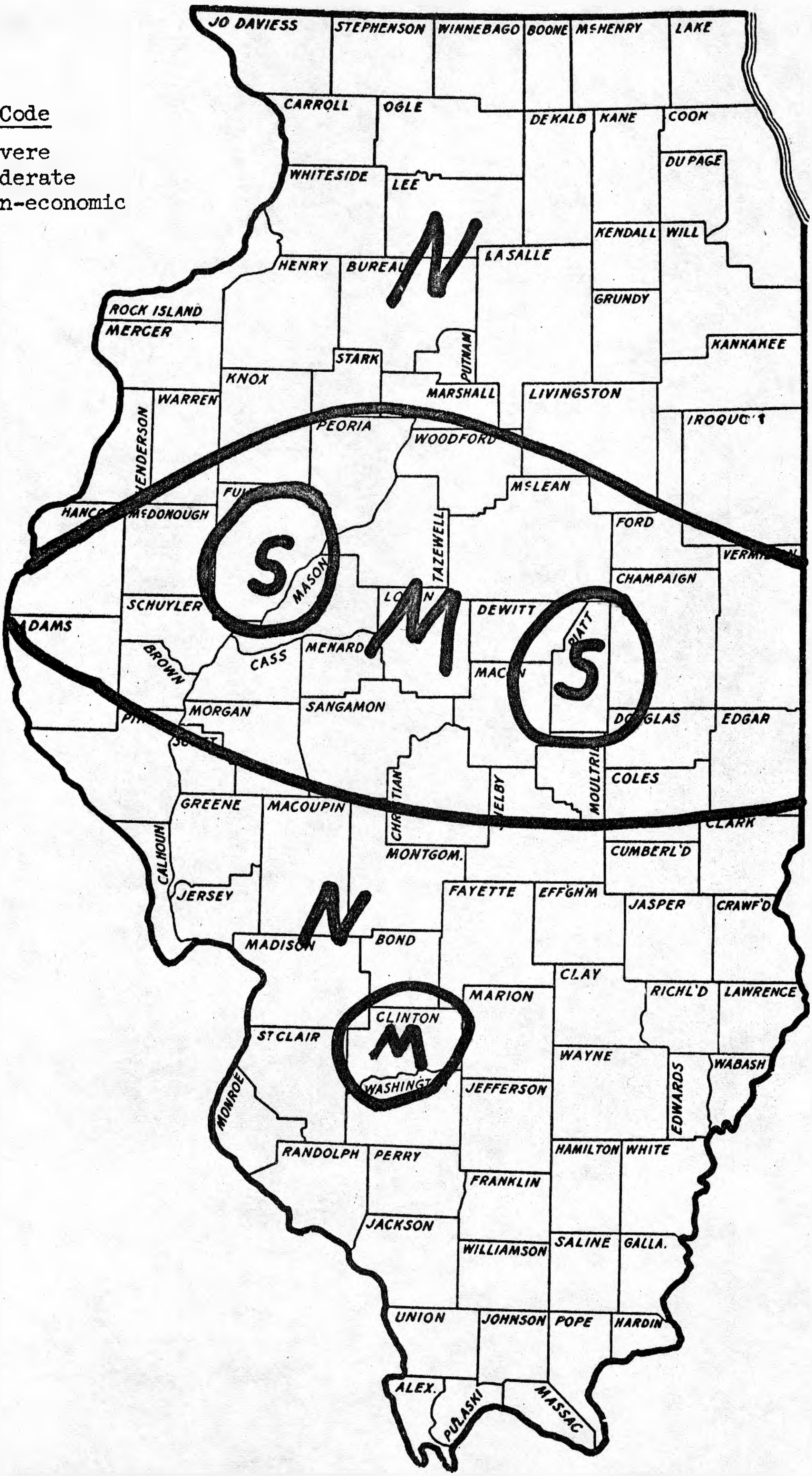
L = Light
N = Non-economic



Map 3.--Chinch Bug Potential, 1958
(Based on the adult fall survey, 11/57)

Code

S = Severe
M = Moderate
N = Non-economic



(Map 4) shows that this coming spring an area in northern Illinois may have one of the most serious spittlebug infestations yet seen in that area. However, if a high percentage of eggs hatch and extremely cold weather occurs afterwards, many of the small nymphs will be killed. If we have a mild spring, we do anticipate trouble from spittlebugs in this northern area. We have no way of knowing where this area stands in the normal population curve, but it is probably at or near the top. It should be noted that the populations in Edgar and Iroquois Counties at one time were high and then suddenly decreased for a period of years, but now they are again increasing. It will be interesting to see how this population curve develops during the next few years. In 1958 the population in this northern area may decrease radically. On the other hand, it may increase for another year or two before it starts to recede. In the area immediately bordering this heavy infestation and extending down through Edgar County on the east, we do anticipate mild infestations. The remainder of the state has a low population. This does not mean that spittlebugs will not be present, but it means that they will not be sufficiently numerous to warrant treatment. To determine the need for the treatment, count the number of spittlebug nymphs per stem from mid-April to the first of May. If the population averages one spittlebug nymph per stem, we believe that control measures will be justified if the hay is needed.

The spotted alfalfa aphid did not present a serious problem in Illinois this year. It first appeared in June and the build-up was extremely slow, but by mid-August to early September a few fields in southern Illinois showed definite signs of damage. Timely rains largely controlled the population. The spotted aphid apparently does not overwinter in Illinois, but migrates from the southwest. After reaching Illinois it may not thrive under our moisture conditions. A dry, late summer and early fall, however, could lead to damage, particularly in fall seedings in southern, west-southwestern, and western Illinois. This year populations of aphid predators in alfalfa fields were relatively low; natural controls were weather and possibly a fungus disease. W. H. Luckmann has already reported on research work on this pest.

Pea aphids did not present a problem this year; they were difficult to find until late in the spring. If the spring of 1958 is either cool, or warm and dry, there are enough pea aphids wintering to create a problem. Moisture and heat favor a fungus disease of pea aphids that probably would control them.

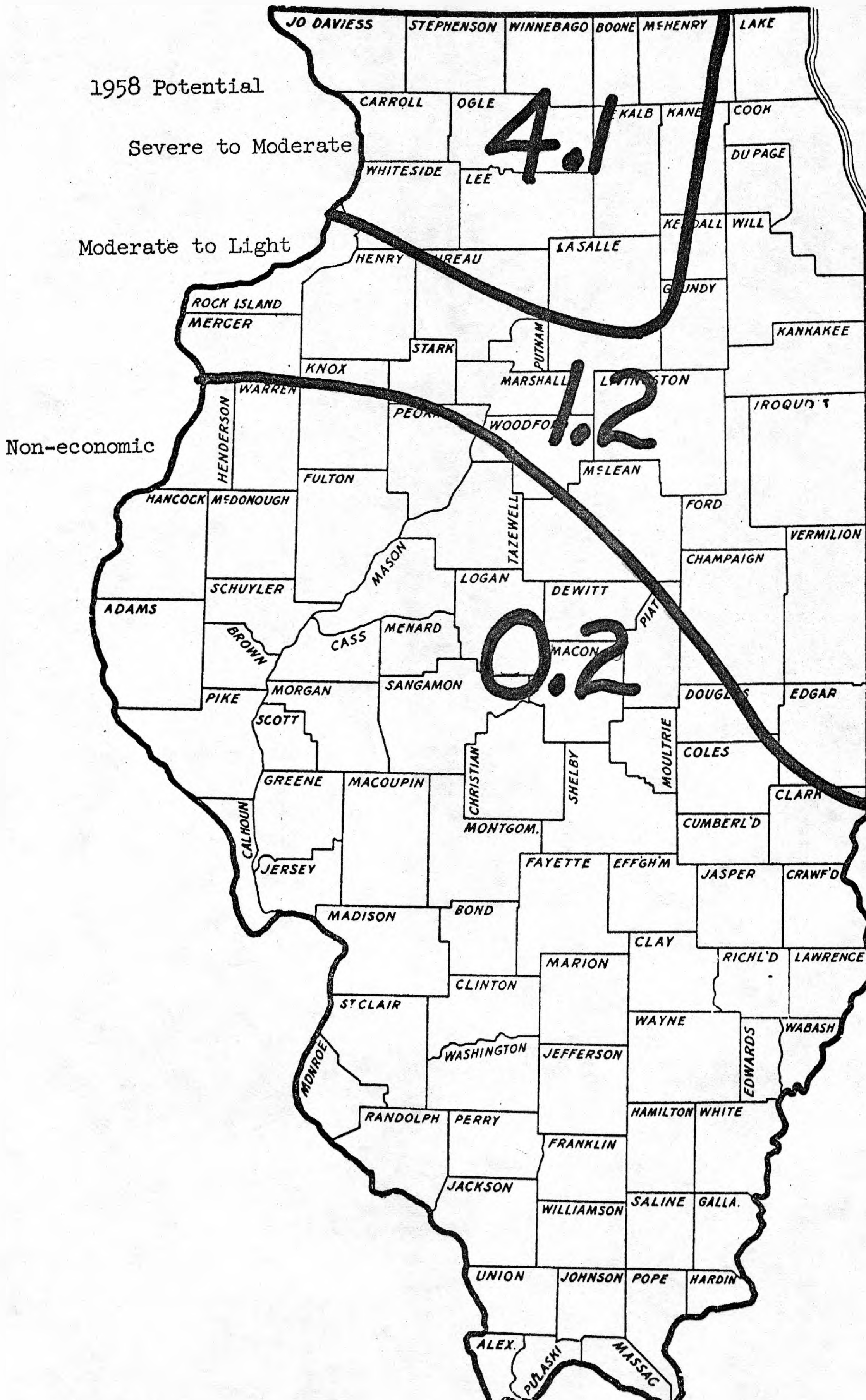
Garden webworms became a problem in alfalfa fields late in the season and in some cases severely damaged new seedings. We have no way of predicting what the possibilities for 1958 may be.

Green cloverworms appeared on soybeans in August and caused moderate defoliation in some fields. However, in most cases disease effectively controlled them and prevented any serious damage.

Bean leaf beetle was fairly abundant in many southeastern soybean fields and caused noticeable defoliation, but the over-all damage was probably not too serious.

Potato leafhoppers, which attack alfalfa, have been studied extensively during the past three years in a north-central regional research project. Dr. George C. Decker of Illinois has been in charge of this project for the midwest. The potato leafhopper causes much of the yellowing, stunting, and purpling of second-growth alfalfa crops. It will also occasionally damage first growth and sometimes third

Map 4.--Average Number of Adult Spittlebugs per Sweep, 9/1/57

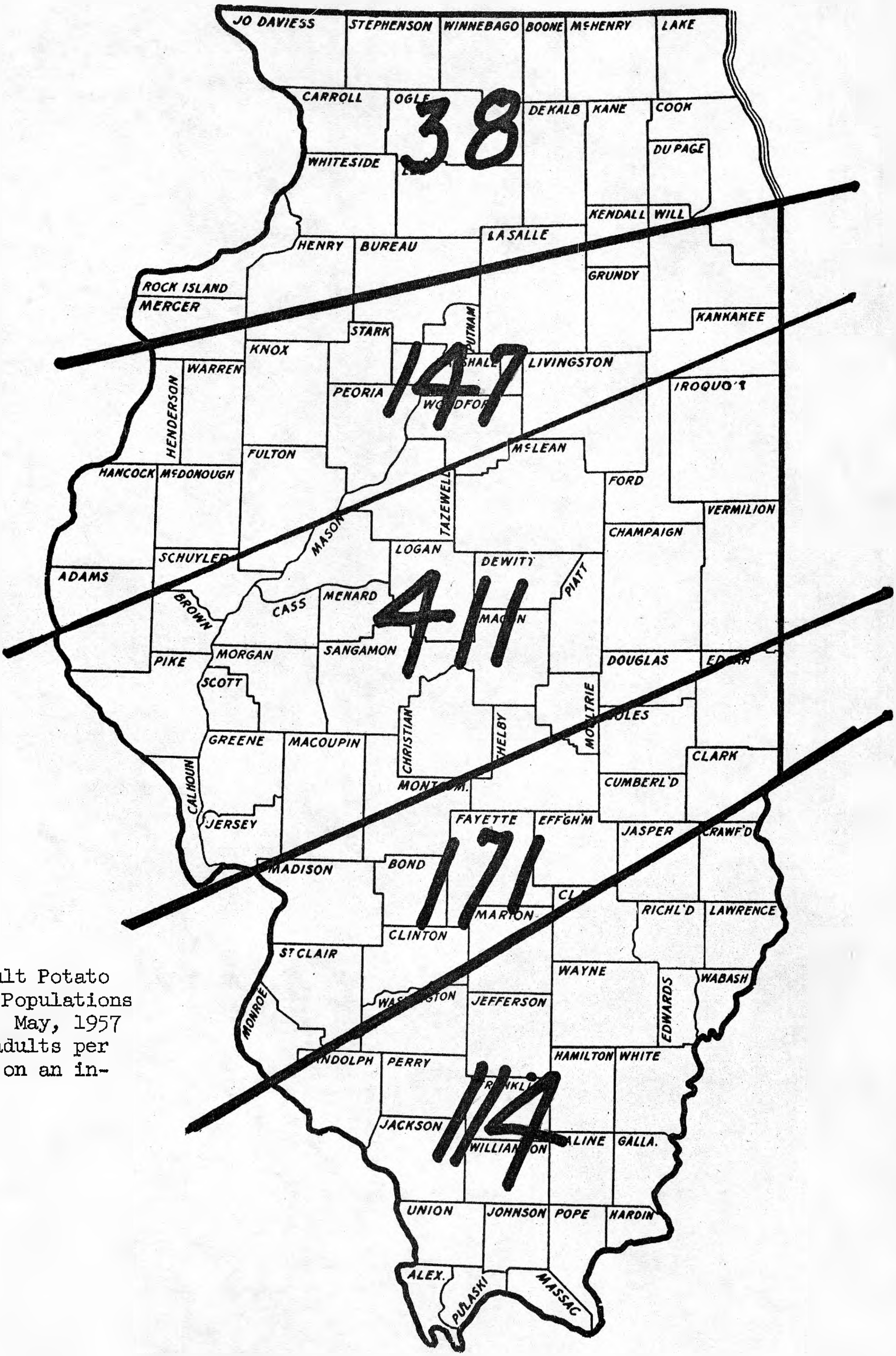


growth. However, the second growth ordinarily is most severely attacked. The hoppers reduce yields, but probably damage hay quality even more. Extensive studies in Wisconsin show that this insect materially reduces the vitamin A and protein content of hay.

The potato leafhopper does not overwinter in Illinois, but migrates in from the extreme southern United States. In late April and early May, a new generation matures in the extreme south and migrates. In a matter of a few days, leafhoppers appear in Illinois. At first, most of the adults are females. However, within a week or two the sex ratio is approximately 50-50. The most striking thing in this migration is its correlation with the upper air currents. Where warm air currents from the south meet cooler air currents from the north, leafhoppers are deposited in a band (see Map 5). This heavier band across Illinois is not the same each year. In some years it is more wedge-shaped, narrower, or farther north or south. Later migrations occur and deposit leafhoppers farther north than is indicated on the map. The population was higher this year than it has been for several years, and leafhopper damage was much more pronounced than usual. Research by the Natural History Survey has shown that the effect on yield may not be so great as appearance of the crop might indicate. Areas were sprayed in each of six fields from Forrest to Yorkville, Illinois. The average difference in yield was about 250 to 300 pounds per acre of dry hay, or 12 to 15 percent. We did not measure the effect on quality. Leafhopper control in many years means better quality second- and third-crop hay. Many farmers do not generally appreciate hay quality as much as quantity.

We anticipated the possibility of a heavy leafhopper population on the third growth that did not take place this year. There undoubtedly was a migration northward. Predator populations and disease may very well have entered into the picture. Leafhopper populations dropped drastically during August.

There are many other insects which we could mention, but predicting their potential for 1958 is impossible. In some instances we do not have sufficient information, and in other instances the insect migrates. Each year we issue our Weekly Insect Survey Bulletin. This is our attempt to keep you posted on the insect situation during the growing season.



Map 5. Adult Potato Leafhopper Populations in Alfalfa, May, 1957 (Based on adults per 100 sweeps on an insect net)

SOIL INSECTICIDE RESEARCH

J. H. Bigger[1/]

During the past year we have carried on our investigations in much the same way as in previous years. We cooperated with 37 farmers and made 80 comparisons of treated and untreated areas on 51 fields, 70 of which were first-year treatments.

In general, the results were the same as in previous years except that infestations were generally lower and results less outstanding.

Because there has not been time to study all the ramifications of our 1957 data, some of the tabulated material included in this report will be averages developed at the end of the 1956 season. With slight changes these will apply to the averages developed to include the 1957 season.

Insect populations were usually lower this year than in some years. The control data in Table 1 show the average results for three important insects for three years, 1954-1956. Other insects were generally controlled as well or better when sufficient amounts of insecticide were applied with this provision. To control cutworms it is apparently necessary to make surface treatments. During 1957 we had three fields in which heptachlor controlled wireworms better than aldrin did.

During the four-years 1953-1956 our records show an average increase of 4.2 bushels per acre, which is approximately 6 percent of the average state yield and corresponds with our showing of a 6 percent increase in plant population later in this report.

Plant population records show a somewhat smaller increase in numbers of plants on treated over untreated areas than in previous years. Insect populations were also smaller. Results over a period of years are given in Table 2.

Further information is available showing the effect of treating with different materials, by different methods, and with recommended or less than recommended amounts of insecticide. Since time is not available to complete all of these studies to include 1957 results, Table 3 gives the information through the 1956 season. The figures do not correspond with those in other tables because the data were used only where comparisons of these particular categories were available.

To bring us up to date, two more tables are included to show where we are going. Table 4 averages results from 1954 through 1956 where broadcast and row treatments were used with recommended or less than recommended amounts of insecticide. Table 5 shows the trend toward use of less than recommended amounts of insecticide, especially in row treatments. Practically all row treatments are in starter fertilizer mixes. We do not know what will happen with the increasing practice of placing starter fertilizer at one side and below the seed, but we are at least somewhat alarmed about the prospects.

We continue to recommend the use of 1.5 pounds of either aldrin or heptachlor per acre broadcast and disked in ahead of planting. An alternate is to use 1.0 pound of either insecticide per acre in the row, but this practice is questionable. Data show that the treatment pays for itself 66 percent of the time and that it pays 100 percent or more dividends 43 percent of the time and 200 percent or more dividends 25 percent of the time. It looks to us like a good insurance risk.

1/ Cooperating with R. A. Blanchard, Entomologist, A.R.S., U.S.D.A.

Table 1.--Average Percent of Control of Three Important Insects by Soil Treatment With Two Insecticides, by Two Methods, and With Recommended and Lesser Amounts of Insecticides

	Percent of control of insects					
	Materials		Methods		Amounts	
Insect	Aldrin treatment	Heptachlor treatment	Broadcast treatment	Row treatment	Recommended amounts	Lesser amounts
Wireworms	78.0	74.0	76.9	78.3	84.6	12.5
White grubs	87.1	82.6	91.9	87.3	91.3	72.2
Rootworms	91.8	80.7	97.5	98.2	98.7	76.7

Table 2.--Plant Population Increases in Treated Over Untreated Areas for Five Years[1/]

Material	Category	1953	1954	1955	1956	1957	4-year[2/] unweighted average
Aldrin	Number of comparisons	37	98	86	40	35	249
	Increased plants per acre	1024	768	616	739	621	697
	Percent increase	9.7	7.2	5.3	6.4	4.7	6.1
Heptachlor	Number of comparisons		7	18	24	21	70
	Increased plants per acre		828	472	833	582	663
	Percent increase		7.4	4.0	7.5	4.3	5.6
All treatments	Number of comparisons		105	94	64	56	319
	Increased plants per acre		770	587	773	605	689
	Percent increase		7.2	5.0	6.8	4.6	6.0

1/ Includes only fields not treated previous year.
2/ Average 1954, 1955, 1956, and 1957.

Table 3.--Increased Numbers of Plants per Acre on Treated Over Untreated Areas of the Same Field for Various Methods of Treatment, 1954-1956

Treatment	Increased number of plants per acre
Insecticide was aldrin	707
Insecticide was heptachlor	700
Applied broadcast	817
Applied in the row	487
Recommended amount used	765
Less than recommended amount used	548

Table 4.--The Effect of Various Combinations of Treatment Procedures, 1954-1956

Treatment combinations	Average increase in plants per acre in treated over untreated areas		
	Number of areas	Plants per acre	Percent
Broadcast with recommended dosages	133	854	7.7
Broadcast with less than recommended dosages	29 1/	705	6.6
Row treatment with recommended dosages	54	550	4.7
Row treatment with less than recommended dosages	23 2/	354	3.1

1/ 17.9 percent of all broadcast treatments.
2/ 29.9 percent of all row treatments.

Table 5.--Trend Toward Use of Less Than Recommended Amount of Insecticide, 1954-1956

Year	Number of fields using recommended dosages		Number of fields using less than recommended dosages		Percent of fields using less than recommended dosages		
	With broadcast treatment	With row treatment	With broadcast treatment	With row treatment	With broadcast treatment	With row treatment	All treatments
1954	56	18	18	5	24.3	21.7	23.7
1955	39	22	5	10	11.4	31.3	19.7
1956	38	12	6	8	13.6	40.0	21.9

CONDENSED INSECTICIDE RECOMMENDATIONS, 1957

H. B. Petty and Steve Moore

Insecticides are safe when used properly and according to directions on recent container labels. Read and follow these directions. However, as a guide, do not apply aldrin, BHC, DDT, or dieldrin to crops whose leaves or stalks are to be fed to dairy cattle or livestock fattening for slaughter. When applying a maximum of $1\frac{1}{2}$ pounds of toxaphene per acre, allow 40 days to elapse between treatment and harvest. Allow three weeks to elapse between maximum applications of 0.3 pound of lindane per acre and harvest, and do not treat alfalfa and clover after they are over 4 inches tall. One pound of malathion or $1\frac{1}{2}$ pounds of methoxychlor may be applied to within one week of harvest; and at present $\frac{1}{4}$ pound of heptachlor to within 7 days of harvest and $\frac{1}{4}$ pound of parathion to within 15 days of harvest. These are, at best, only general indicators or rule-of-thumb guides but, if generally followed, should prevent residue problems.

The above-listed times are not required for safety of animals feeding on forage crops, but to prevent contamination of milk, milk products, or meat with insecticides and thus protect the consuming public.

In the tables on the following pages, all insecticides are listed alphabetically. The listing has nothing to do with preference or cost.

FIELD CORN INSECTS

Insect	Approximate time of attack	Insecticide[1/] Name	Insecticide[1/] Lb. of active ingredient per acre	Placement of insecticide	Timing of application
Seed-corn maggot Seed-corn beetle	At time of germination	Aldrin Dieldrin Heptachlor Lindane	According to manufacturer	On seed	At planting time (also soil applications as for wireworms)
Southern and northern corn rootworm	June through August	Aldrin Dieldrin Heptachlor	1 1/2 1 1 1/2 If banded, 1 lb. per acre	In soil " "	Within two weeks of planting. If broadcasting, work into soil immediately. If by planter, at planting time.
Wireworms	As for rootworms: seed treatment erratic				
Grape colaspis	As for rootworms: suggested for further trial after clover or soybeans				
White grubs	June-October	Aldrin Heptachlor	3 3	In soil	Two to three weeks before planting
Sod webworm	May and June	DDT	1 1/2	Over row	At time of initial attack
Cutworms	May and June (Soil treatments broadcast as for rootworm usually effective)	Dieldrin Toxaphene	1/2 3	At base of plant	When damage is first noticeable; high gallonage of finished spray needed
Grasshoppers	June through September	Aldrin Dieldrin Heptachlor Toxaphene	1/8 to 1/4 1/8 to 1/4 1/8 to 1/4 1 1/2	Entire plant (At present, heptachlor only one with label clearance for ensilage uses)	As needed.
Flea beetles	May and June	DDT Dieldrin	1 1/2 1/4	Over row	When damage becomes apparent
Armyworms	May and June	Dieldrin Toxaphene	1/4 1 1/2 to 2	Over row	At first migration
Fall armyworms	June through September	DDT Toxaphene (If applied by plane, granules preferred)	1 1/2	On portion of plant being damaged	When plants show leaf ragging. When silking (see earworm)
Chinch bugs	June, July, August	Dieldrin	1/2	At base of plant and strip in adjacent field	At first start of migration.
Corn borer, first generation	June-July	DDT	1 1/2 as a spray; 0.75-1.0 as granules by ground or 1.0 by airplane	Upper 1/3 of plant and particularly into whorl	Between tassel ratio 30 and 50 if 75 percent or more of plants have fresh borer feeding in whorl. Usually in early fields.

1/ Observe residue precautions on labels.

Insect	Approximate time of attack	Insecticide: Name	Insecticide: Lb. of active ingredient per acre	Placement of insecticide	Timing of application
Corn borer, second generation	Mid-August	DDT	As for first generation	From ear upwards	When eggs are first found hatching in late-planted fields.
Corn earworm	July & August	DDT	1 1/2 plus 2 gal. of earworm oil	Ear zone	2 to 4 applications at 3- to 5 day intervals, starting at 10% silk. 25 gal. of finished spray per acre.

1/ Corn to be used as ensilage or stover for dairy cattle for slaughter should not be treated with insecticides unless label directions on the container permit its use. Some insecticides can be used on ensilage corn for fattening livestock provided certain restrictions are followed.

CLOVER AND ALFALFA INSECTS[1]

Insect	Approximate time of attack	Insecticide[2] Name	Insecticide[2] Lb. of active ingredient per acre	Placement of insecticide	Timing of application
Clover leaf weevil	March-April	Lindane Toxaphene	0.3 gamma 1 1/2	On foliage	When larvae are in evidence and damage is noticeable, usually early to mid-April. For fall treatment use DDT.
Spittlebugs	Late April and early May	Lindane Heptachlor Methoxychlor Toxaphene	0.3 gamma 6 oz. 1 1/2 1 1/2	As foliage spray	When bugs begin to hatch and tiny spittle masses are found in crown of plants. For fall treatment use DDT.
Aphids[3]	April-May	Malathion Parathion	1 0.25	On foliage	When aphids are becoming prevalent, but prior to packing on stem and curling and dying of leaves. Parathion should be applied by professional operators only.
Leafhoppers	Early July	Methoxychlor	1 to 1 1/2	On foliage	When second-growth alfalfa is 1 to 6 inches high.
Garden webworm	July-August	DDT Methoxychlor Toxaphene	1 1/2 1 1/2 1 1/2	On foliage	When first damage appears, use methoxychlor on hay crops and DDT or toxaphene on seedlings.
Cutworms	April-May	Dieldrin Toxaphene	1/4 1 1/2 to 2	On foliage	Observe residue precautions. Usually applied as soon as 1st cutting is removed and only if severe defoliation is occurring.
Seed crop insects	July-August	DDT	1 1/2	On foliage	No later than 10% bloom.
Grasshoppers	June through September	Aldrin Heptachlor	1/4 1/4	On foliage	Aldrin to within 14 days of harvest. Heptachlor to within 7 days of harvest.
Sweet clover weevil	April-May	DDT	1 1/2	On new seedings	When 50% of foliage has been eaten.

1/ Do not apply insecticides when insects are pollinating these crops.
2/ Follow residue precautions on the labels and read opening remarks carefully.
3/ Some systemic insecticides may be recommended in the near future.

SMALL GRAINS AND GRASSES

Insect	Approximate time of attack	Insecticide[1/] Name	Lb. of active ingredient per acre	Placement of insecticide	Timing of application
Grasshoppers	June-July August	Aldrin Dieldrin Heptachlor Toxaphene	1/8 to 1/4 1/4 1/4 1 1/2	On entire plant	Watch new seedings. Control grasshoppers early while they are small and before they are scattered over a wide area.
Chinch bugs	June-July	Dieldrin	1/2	General, but at ground level is best	Apply when bugs are damaging wheat and during migrations. Treatment of grain strip essential when protecting corn. Strip can be treated up to within one week of harvest.
Armyworms	May-June	Dieldrin Toxaphene (Methoxychlor, 2 lb. per acre, will prevent worms from feeding. Less objectionable if pastures are involved.)	1/4 1 1/2 to 2	On foliage	When worms are still small but are crawling up on plant. Control worms before damage is done.
Greenbugs	May-June	Parathion	1/4	On foliage	When needed and by professional operators only.

1/ Follow residue precautions.

SOYBEAN INSECTS

Insect	Approximate time of attack	Insecticide 1/ Name	Lb. of active ingredient per acre	Placement of insecticide	Timing of application
Bean leaf beetle	May-June-August	DDT	1 1/2	On foliage	When defoliation becomes severe or when pods are attacked.
		Dieldrin	1/4		
		Toxaphene	2		
Grape colaspis	May-June	Aldrin	1 1/2	In soil prior to seeding	Within two weeks of planting. On 2nd-year beans or beans after clover. Not recommended, but suggested for trial only.
		Dieldrin	1		
		Heptachlor	1 1/2		
White grubs	June through September	Aldrin	3	As soil treatment	Two weeks before planting.
		Heptachlor	3		
Clover root curculio adults	May-June	DDT	1 1/2	On marginal rows	Usually when adjacent clover field is plowed up, this pest migrates to adjoining beans.
Grasshoppers	June through August	Aldrin	1/8 to 1/4	On foliage	When migrations from adjoining crops begin. For border spray use 1 1/2 to 2 times as much.
		Dieldrin	1/4		
		Heptachlor	1/4		
		Toxaphene	1 1/2		
Flea beetles	May-June	DDT	1 1/2	On foliage	Plants usually attacked in seedling stages. Treat when needed.
		Dieldrin	1/4		
		Toxaphene	1 1/2		
Green clover worm	August	DDT	1 1/2	On foliage	When damage becomes noticeable and small worms are abundant.
		Toxaphene	1 1/2		
Webworms	June-July-August	DDT	1 1/2	On foliage	When damage appears and small worms are numerous.
		Toxaphene	1 1/2		

1/ Follow residue precautions.

MOSQUITO CONTROL

P. Bruce Brockway, Jr.

There always is a great deal of interest in mosquito control during their biting season; however, generally speaking, the public does not take a great deal of interest in the subject during the time when preventive measures can be taken. As a result, the pest control operators, or custom spray operators, are asked to step in and do their part for mosquito control during the worst time to do an adult mosquito control project.

There have been times when many of us have been asked for advice and that advice more or less backfired on us because we did not have adequate information. For an effective adult mosquito control project it is necessary to have all the available information on species as well as density. With information on the species a spray operator can generally find without too much difficulty just where the mosquitoes are emerging from, and with this knowledge of the species of mosquitoes in the vicinity, an operator can then investigate and know the different habits of the mosquito, not only in the larval stage but also in the adult.

Armed with this information, an operator can put into process a project of control that will be a credit to himself and definitely have a much happier community.

About ten years ago fog machines were a new machine and we believed them to be the complete answer to mosquito control. People looked at them as a type of magic wand that could answer every adult mosquito control problem. We have since learned that this is not quite true because mosquitoes can replace those already killed by a passing fog machine. Also, fog machines are subject to weather conditions and the apparatus itself sometimes does not exactly act as the operator would desire. Therefore, when comparing the end result from the fogging operation and the monies expended, it is sometimes difficult to justify the complete expenditure.

Adult mosquito control with the use of mist machines has its definite advantages over the fog machines because the mist machines are not subject to the same weather conditions. Furthermore, the mist machines leave a residual on the foliage in the area under adult mosquito control, but the undesirable factor is that the mist cannot be used in residential areas because the mist would leave a spotty effect on laundry, windows, etc.

There is no substitute for a good larviciding operation. Find the mosquitoes and kill them is just as true today as it was sometime ago. The early spring mosquitoes that emerge in April or May can be controlled through the use of prehatch dusting program and, in some areas, a DDT emulsifiable treatment has been successful. During the summer we generally encounter the *Aedes vexans* or the *Culex pipiens* mosquitoes in large numbers. The *Aedes vexans* is what we in the Toledo area refer to as the field-floodwater mosquito and this mosquito emerges a few days after a heavy rainfall and when the fields are covered with water to a depth of from two to three inches. The *Aedes vexans* is a long flight mosquito and generally lives from four to six weeks. Its habit is to annoy those people using their backyards and gardens. The *A. vexans* does not make a habit of entering residences.

The *Culex pipiens* is a domestic mosquito and does enter the residence, and it is also closely associated with polluted waters for its larval stage. The *C. pipiens* is attracted by light and will make every effort to get into a lighted house.

All mosquitoes follow the same aquatic cycle; namely, the egg, larva and pupa. The length of time that a mosquito remains in the water or the aquatic stage depends on the temperature of the water and the food supply present. Of course, it is always desirable to do mosquito control on a permanent basis such as the removal of water by drainage or the filling of some water holes. However, this control measure is not always available, especially under a curtailed program such as those that the custom spray control operator is probably called to assist on. Therefore, in the Toledo area we use a basic larvicide of 5% DDT in fuel oil during the spring months and this DDT is reduced to a 1% solution during the dry summer months.

In some of the permanent ponds or pools the mosquito larvae--eating fish, Gambusia affinis, can be introduced if vegetation along the margins is kept to a minimum. Storm drains, catch basins, etc., can at least be controlled through the introduction of 5% DDT in fuel oil at the rate of approximately six ounces per catch basin, and this application is made at least three times a summer.

Efforts on the part of each custom operator should be made to use just the DDT formulations. In the Toledo area we have not encountered any problem of resistance or tolerance to the DDT insecticides. There may be an occasion when there will be a doubt in the operator's mind as to the killing ability of a DDT larvicide. However, in the Toledo area we have found this only true when the area encounters a high degree of pollution together with high temperatures. Larval control by spray may for a short period of days reduce control factors. When this problem is encountered, we have been switching over to the old standard New Jersey Larvicide with one-tenth percent pyrethrum on the polluted water.

Operators are encouraged to hesitate rather than emphasize the use of chemicals higher on the chain of hydrocarbons and phosphates. The operators should also remember that they have an obligation when using insecticides to use only those materials that are safe to handle and not a health hazard or a possible danger to wildlife.

A movie will be shown of the pieces of control equipment and the various means of applying insecticides in a mosquito control operation.

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